A CAHNERS PUBLICATION INTERNATIONAL EDITION MARCH 18, 1987

EDN

Breadboarding facilitates gate-array development

CMOS FIFO buffers employ memory architectures

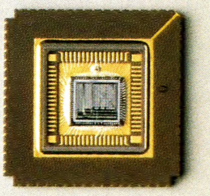
Fast-settling op amps aid data-conversion tasks

Electro '87 preview

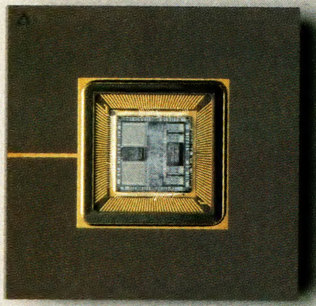
19 MAY RECD

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

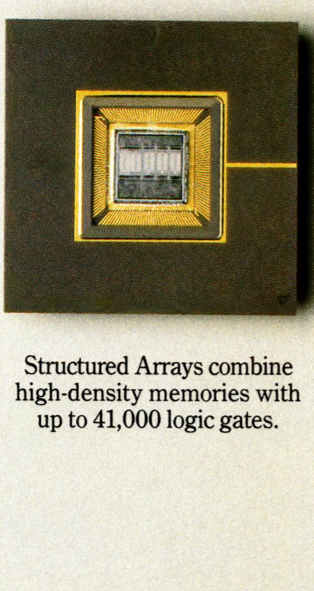
Complex layouts emerge from low-cost systems



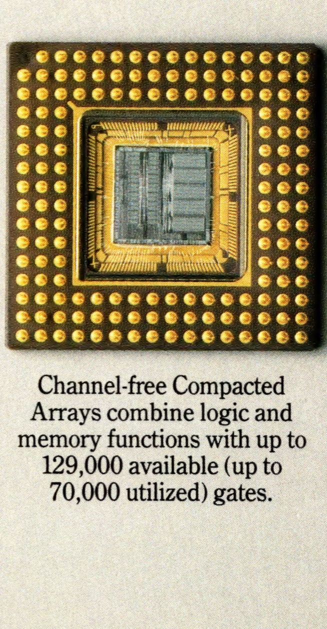
Our MACGEN silicon compiler developed the world's fastest 16-bit multiplier accumulator.



High Performance cell-based 1750 CPU combines logic, ROM and processors.



Structured Arrays combine high-density memories with up to 41,000 logic gates.



Channel-free Compacted Arrays combine logic and memory functions with up to 129,000 available (up to 70,000 utilized) gates.

If your system design looks good on a board, think how impressive it's going to look on a single chip.

Which is precisely where our 1.5-micron ASIC technology will put it.

Now every design is downsized, whether you're working with our Standard and Structured Cells,™ or Structured Arrays™ and channel-free Compacted Arrays.™ Or our silicon-compiled 16-bit and 32-bit MAC chips.

All of them let you design a more powerful system with fewer components and fewer bugs. A system with more functions, in less space.

But it's not just our 1.5-micron CMOS technology that makes your designs more efficient.

It's also our ASIC design tools that let you create any cell or array solution with the same proprietary software methodology.

Use our LDS™ core software with any one of our fifteen add-on modules. Like the advanced behavioral or multi-chip simulator, chip floorplanning or logic simulation accelerator.

And you're guaranteed working parts whether you design on your own mainframe, mini or engineering workstation. Or at any of our 30 ASIC design centers—the largest network in the world.

We've shortened prototype delivery time, too. A mere five to six weeks for Structured Cells, three for Compacted Arrays and Structured Arrays, and as little as ten days for Gate Arrays.

Call your nearest LSI Logic design center, or send us your system design problem. We'll show you just how quickly you can jump into higher integration.

Without going overboard.

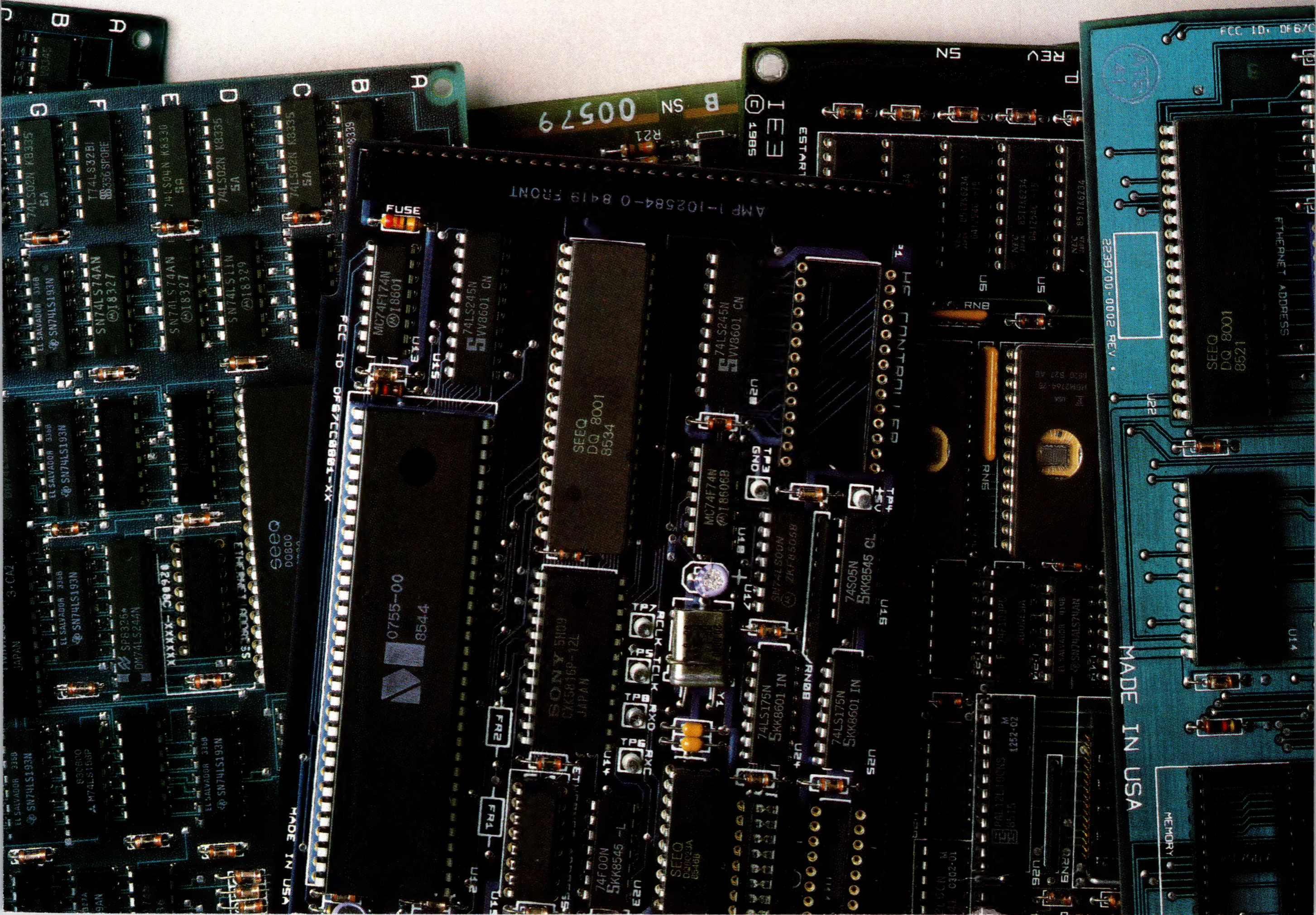
LSI LOGIC

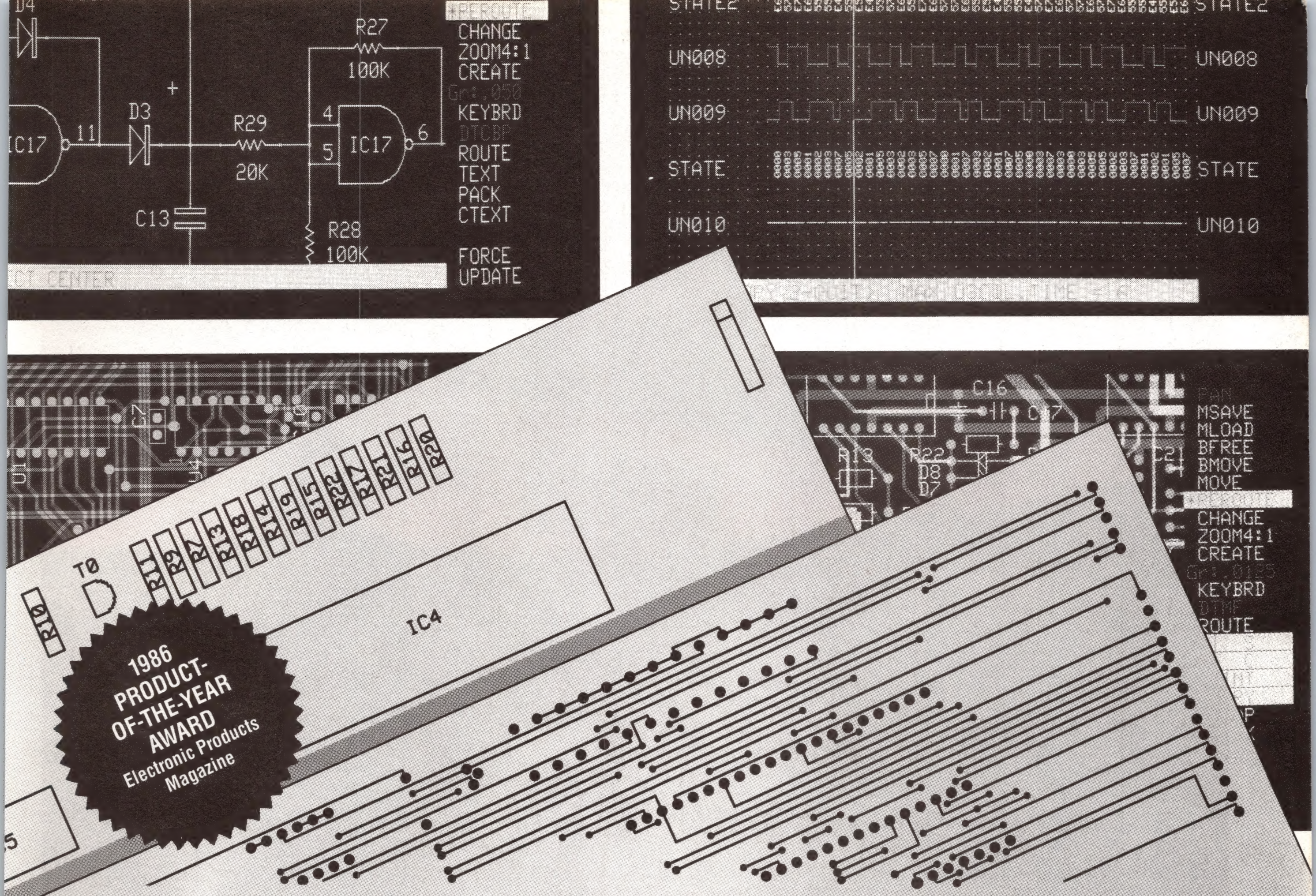
LSI Logic Sales Offices and Design Centers: Milpitas, CA 408-433-8000, San Jose, CA 408-248-5100, Irvine, CA 714-474-2960, Sherman Oaks, CA 818-906-0333, Denver, CO 303-756-8800, Westport, CT 203-222-9336, Altamonte Springs, FL 305-339-2242, Boca Raton, FL 305-395-6200, Bethesda, MD 301-897-5800, Chicago, IL 312-773-0111, Waltham, MA 617-890-0161, Ann Arbor, MI 313-769-0175, Minneapolis, MN 612-835-6161, Poughkeepsie, NY 914-454-6593, Raleigh, NC 919-783-8833, Trevose, PA 215-638-3010, Austin, TX 512-343-4513, Dallas, TX 214-788-2966, Bellevue, WA 206-822-4384, Calgary, Alta 403-262-9292, Edmonton, Alta 403-424-8845, Kanata, Ont 613-592-1263, Toronto, Ont 416-622-0403, Paris, France 33-1-46-21-25-25, Israel 972-3-403741, Ibaragi-ken, Japan 81-298-52-8371, Tokyo, Japan 81-3-589-2711, Osaka, Japan 81-6-947-5281, Sweden, 46-8-520720, United Kingdom, 44-344-426544, Munich, West Germany 49-89-926903-0, Düsseldorf, West Germany 49-211-5961066, Stuttgart, West Germany 49-711-2262151. Distributors: Hall-Mark; Hamilton/Avnet; Schweber; Wyle.

LDS is a registered trademark, and Compacted Arrays, Structured Arrays and Structured Cells are trademarks of LSI Logic Corporation.

CIRCLE NO 49

HOW TO AVOID GOING OVERBOARD.





EE DESIGNER™

PROFESSIONAL CAE/CAD SOFTWARE STARTING AT $975.

A clear path through the CAE/CAD software maze. There are many CAE/CAD systems on the market today, but most are unproven in the work environment. With over 2,000 packages sold, the one system that has been getting the job done where it counts is EE Designer!

This is the IBM PC-based end-to-end CAE/CAD system that performs. Professionally. And affordably. That's why it's quickly become first choice of small and large companies alike. And the latter category includes companies like ***AT&T, Eastman Kodak, General Electric, IBM, Motorola, Sony, Texas Instruments, Westinghouse,*** and ***Xerox,*** to name just a few.

Join them and more than a thousand other companies in making the smart move—risk free. Order EE Designer or the advanced EE Designer II, try it for 30 days and be fully satisfied or your money back.

EE Designer. Schematic capture, digital logic simulation, manual interactive layout, limited multilayer capability. **$975.**

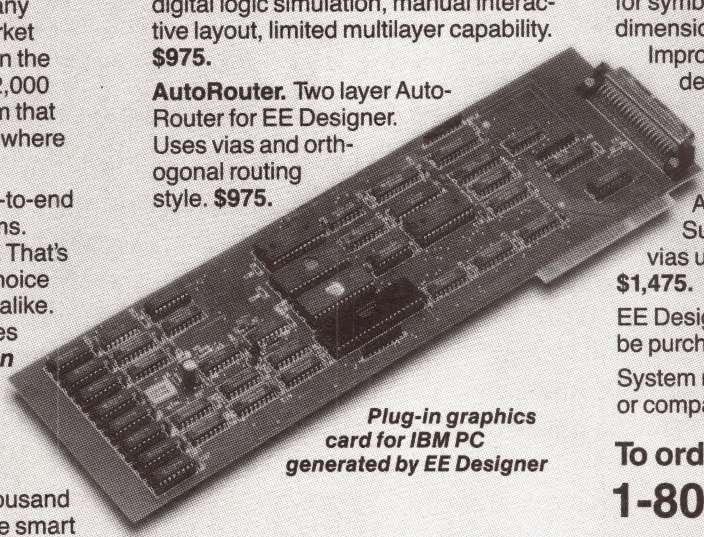
AutoRouter. Two layer AutoRouter for EE Designer. Uses vias and orthogonal routing style. **$975.**

EE Designer II. Schematic capture, digital logic simulation, manual interactive layout, extended multilayer and surface mount (SMD) capability, enhanced graphics for symbol creation, dimensioning capabilities. Improved facilities for analog board design (improved ground planes, user definable trace widths.) **$1,875.**

AutoRouter II. Multilayer AutoRouter for EE Designer II. Supports routing with or without vias using orthogonal routing style. **$1,475.**

EE Designer II and AutoRouter II may be purchased together for **$2,975.**

System requirements: IBM PC/XT/AT or compatible with 640K memory.



Plug-in graphics card for IBM PC generated by EE Designer

To order, call toll-free
1-800-553-1177

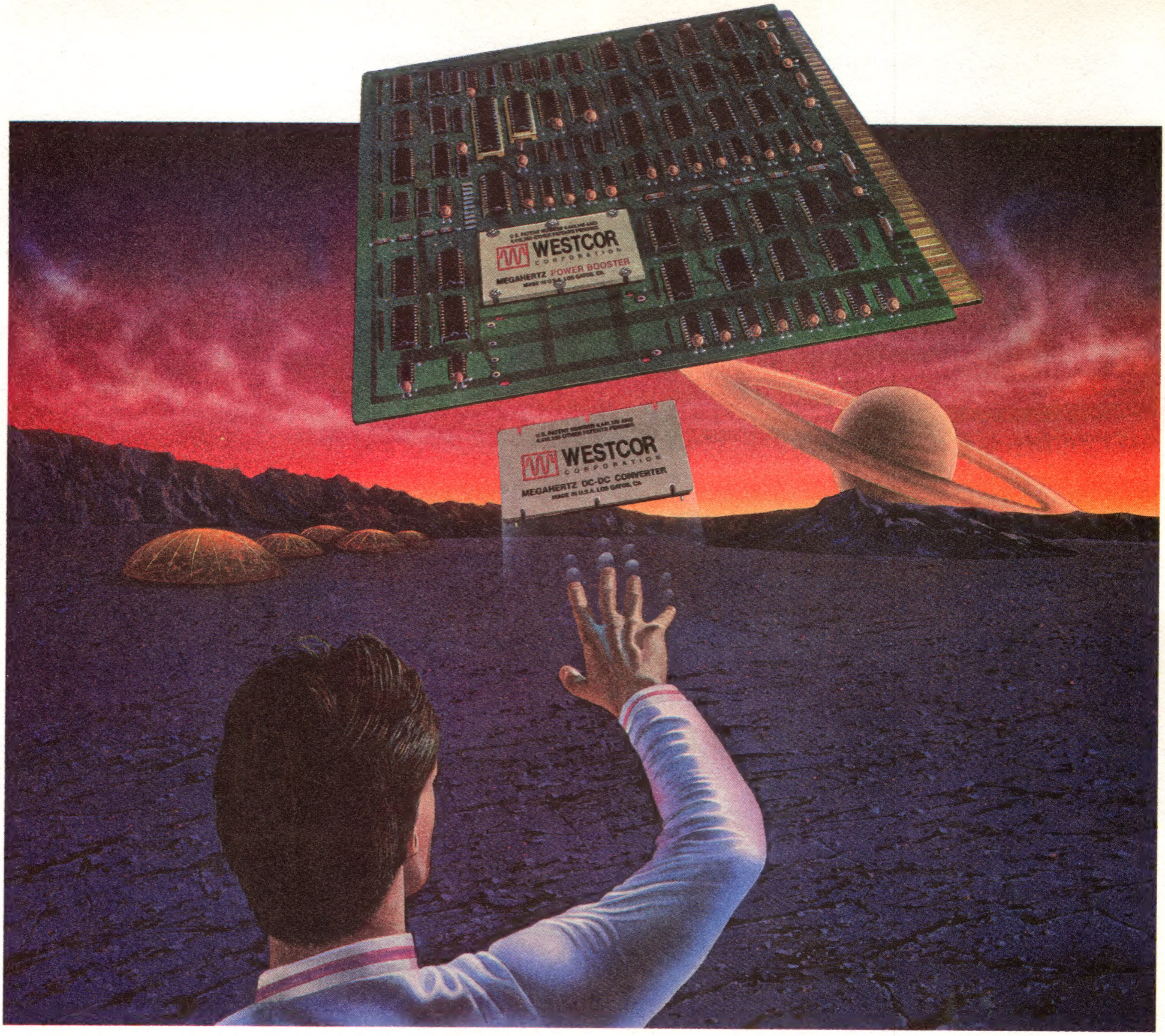
VISA MasterCard

VISIONICS®
CORPORATION

343 Gibraltar Drive
Sunnyvale, CA 94089
(408) 745-1551

IBM PC, XT and AT are trademarks of International Business Machines Corp.

CIRCLE NO 8



LET WESTCOR POWER YOUR SYSTEM INTO THE 21ST CENTURY.

Westcor VI-100™ DC-DC converters put you ahead in the space race by putting more power — up to 200 watts — into a remarkably compact 2.4 × 4.6 × .47 inch 6 oz. modular package. Patented megahertz operation, the key to attaining such stellar power density, also reduces output noise and ripple. Booster modules provide kilowatts of power by simple, one wire, Gating Pin Paralleling with current sharing.

VI-100 converters support input voltages from 10 to 425 VDC and isolated outputs from 2 to 48 VDC. That means there's a Westcor converter for almost every system need in the galaxy, including military and telecommunications applications. And Westcor offers UL, CSA and VDE (TUV)-approved models for distributed power or other 110/220 off-line systems.

All VI-100s are encapsulated and built to take it — their MIL 810 and MIL217D specs illustrate it and our minimum two-year warranty guarantees it.

Industrial and Military grade modules with 3 and 5 year warranties and special testing are also available.

Find out more about Westcor Megahertz DC-DC converters and how they can power your system designs to new dimensions. Call us at 408-395-7050, TWX 910-240-2108.

CIRCLE NO 47

WESTCOR CORPORATION • 485-100 Alberto Way • Los Gatos, CA 95030 • (408) 395-7050 • TWX 910-240-2108

WAVETEK®

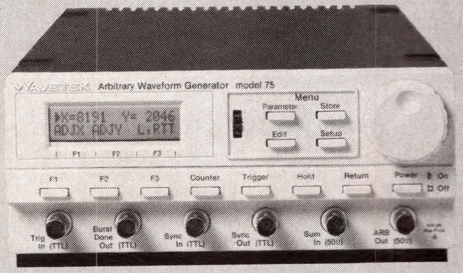
Make any waveform come to life.

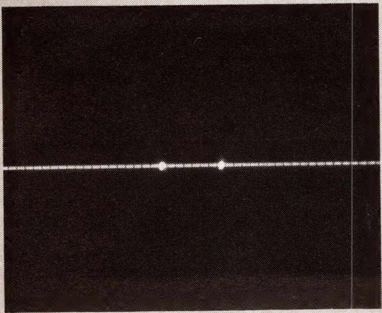
Now you can create arbitrary waveforms in real time just by using your oscilloscope screen. Our new Model 75 Arbitrary Waveform Generator gives you the tools to quickly produce any arbitrary waveshape: insert standard waveform segments, adjust their offset and amplitude, and create non-standard waveforms with our "thumbtack and rubberband" editing system. You can program an entire function visually without ever entering an x/y coordinate.

With more than 4,000 vertical and 8,000 horizontal points available, the most complex waveforms can be created and then stored in Model 75's nonvolatile memory. You can play the waveform back at any rate, then edit it point by point.

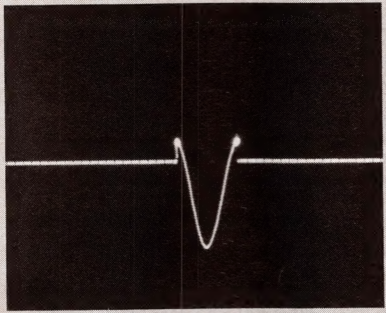
By linking two or more Model 75's together and using their internal counters, sequences of "normal" waveforms can be mixed with bursts of "abnormal" ones, or multiples of a function can be output with phase displacement. An optional IEEE-488 (GPIB) or RS232C interface is also available.

For more information call or write Wavetek San Diego,
P.O. Box 85265,
9045 Balboa Ave., San Diego,
CA 92138. Phone (619)
279-2200; TWX (910)
335-2007.

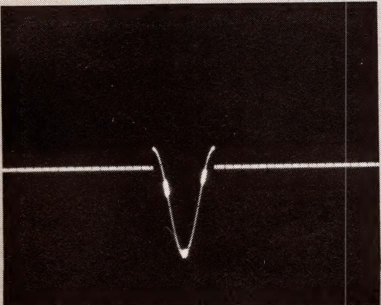




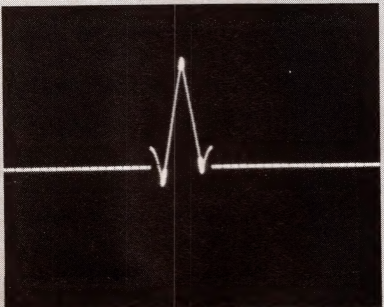
1. Place "thumbtack" markers.



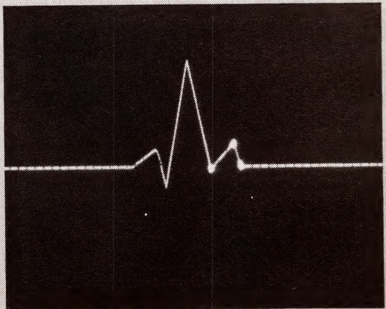
2. Insert standard waveform.



3. Reset "thumbtack" marker positions.



4. Stretch "rubberband" with edit cursor.

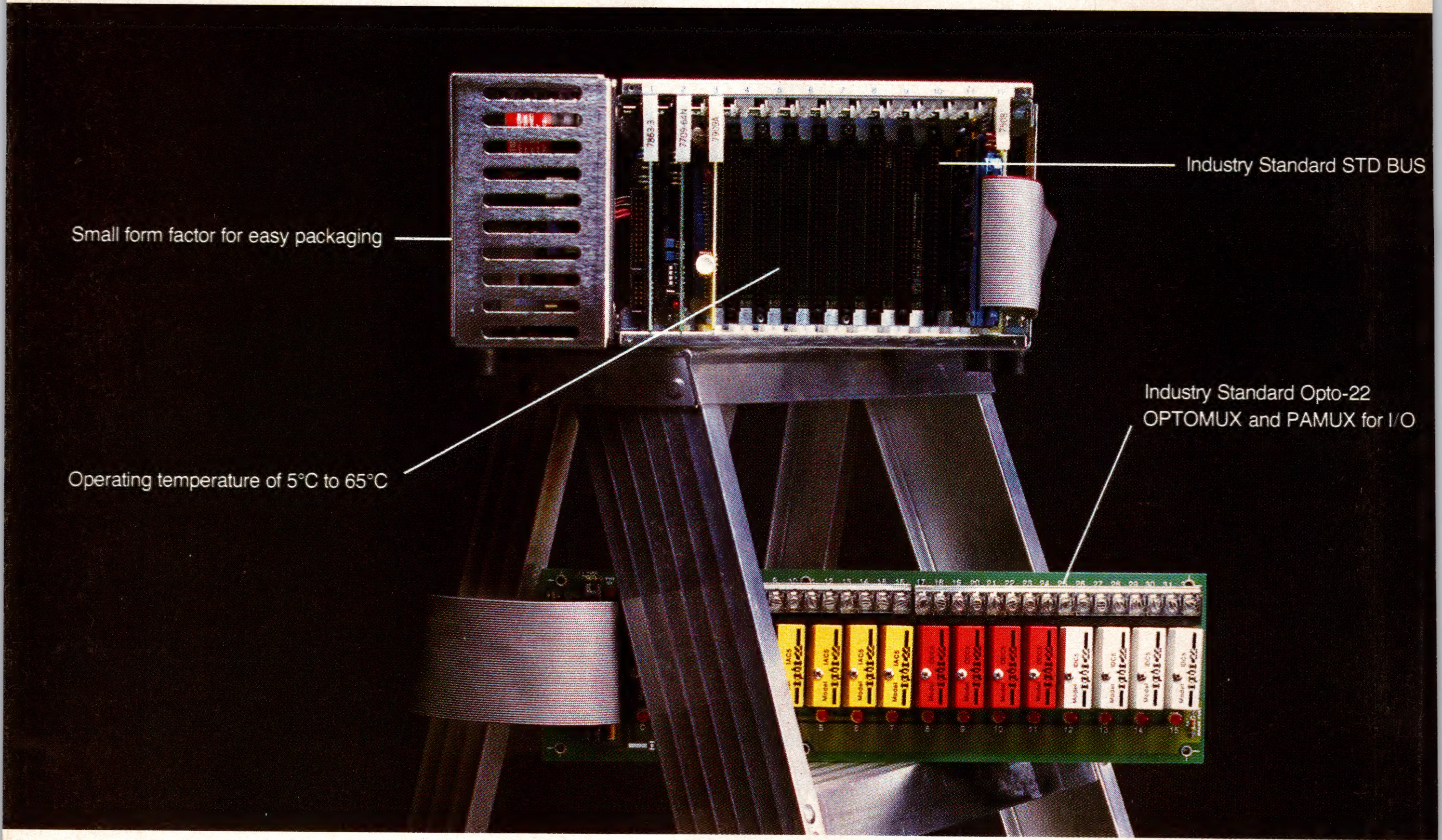


5. Move "thumbtacks" and complete waveform editing.

Circle 48 for demonstration

Circle 9 for literature

REAL-TIME MULTITASKING INDUSTRIAL CONTROL WITHOUT BEING LOCKED INTO A PROGRAMMABLE CONTROLLER


Industry Standard STD BUS
Small form factor for easy packaging
Industry Standard Opto-22 OPTOMUX and PAMUX for I/O
Operating temperature of 5°C to 65°C

How? By using Pro-Log's new System 1 Industrial Computer.

Like a programmable controller, System 1 runs relay ladder programs . . . but with many enhanced features such as 4-function math, stepper drums, and PID loops.

Unlike a programmable controller, System 1 is based on an industry standard: the STD BUS. So you get a modular system that you can easily upgrade — a system supported by a large number of vendors and one that won't change next year. I/O expansion is also based on industry standards, like Opto-22's OPTOMUX and PAMUX.

Reliability is the number one concern on the factory floor. System 1 has a Mean Time Between Failures (MTBF) of over 5 years, a Mean Time To Repair (MTTR) of under 5 minutes, and Pro-Log covers it with a 5-year parts and labor warranty.*

And, if you're not convinced yet that System 1 suits your control application, we've built in the capability to add a second processor that runs Microsoft's MS-DOS. (MS-DOS is the operating system of the personal computer.)

So, while one processor is handling the real-time demands of your control system, the other is handling the real-time demands of your job: Like data analysis, communications, or generating management reports.

You program System 1 with an IBM PC or compatible and the RD-1000 Relay Ladder Logic Editor/Monitor, at your desk or on the factory floor. RD-1000 lets you create, modify, document, download, and test your relay ladder control program. RD-1000 is distributed by Pro-Log.

Unlock yourself from the programmable controller! Call Pro-Log today: (800) 538-9570, inside California (408) 372-4593. Or write to Pro-Log Corporation, 2560 Garden Road, Monterey, CA 93940.

SYSTEM 1 SUPPORTS:

- 4-Function math
- Compare and jump
- 1040 Digital I/O
- 416 Analog I/O
- 120 Timers
- 100 Counters
- 20 Shift registers
- 32 Stepper drums
- 2000 Set points
- 6000 Control relays
- 40 PID loops

RD-1000 is a trademark of CPI Industrial Software, a division of Control Process.

Microsoft and MS-DOS are registered trademarks of Microsoft Incorporated.

IBM PC is a registered trademark of International Business Machines.

PRO-LOG®
CORPORATION

USA TLX: 171879; Australia (02) 419-2088; Canada (416) 625-7752; England (0276) 26517; France (1) 3956-8142; Germany (07131) 50030; Italy (2) 498-8031; Switzerland (01) 62 44 44.

ADGROUP INTERNATIONAL PL053

---

*Excludes power supply

Circle 44 for literature request only **Circle 5 for direct factory contact**

Volume 32, Number 6

EDN

March 18, 1987

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

On the cover: Layout projects that once required a dedicated workstation or the use of a service bureau can now be accomplished on personal computers, thanks to high-performance software packages that cost less than $15,000. See pg 138. (Photo courtesy Racal-Redac)

DESIGN FEATURES

Special Report: Low-cost pc-board layout software 138

Inexpensive programs can now complete pc-board layouts that once required mainframes or dedicated workstations. These programs, which typically run on personal computers, are automatic as well as interactive. You needn't use the packages often to become proficient with them—they're easy to learn and to use.—*Eva Freeman, Associate Editor*

Optimize your graphics system for 2-D and 3-D 161

The design of a graphics system that's both 2-dimensional and 3-dimensional poses some conflicting requirements. You can reconcile some of these conflicts, however, through careful design of the frame-buffer structure, and you can achieve adequate speed for 3-D applications by using parallel processors for computation-intensive tasks. —*Anoop S Khurana and Olivier Garbe, Advanced Micro Devices Inc*

Fast-settling op amps aid in data conversion 185

When you use an op amp to buffer a high-speed data-conversion device, you must match the speed of the op amp to that of the D/A or A/D converter you're using. Unless your op amp's settling-time characteristics are comparable to those of the converter, the converter's fast performance will be wasted.—*Charles Kitchin, Scott Wurcer, and Lew Counts, Analog Devices Semiconductor*

Combine C and assembly language for the 8086/88 195

You can write programs containing both C and assembly-language code for designs based on the 8086/88 µP. To write such programs, you must make your C and assembly-language routines compatible with each other.—*William C Warner, Consultant*

Continued on page 7

EDN (ISSN 0012-7515) is published 45 times a year, biweekly with one additional issue in January, February, March, August, and December, two additional issues in April, June, July, September, and November, and three additional issues in May and October by Cahners Publishing Co, a Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158. William M Platt, President; Terrence M McDermott, Executive Vice President; Jerry D Neth, Vice President of Publishing Operations; J J Walsh, Financial Vice President/Magazine Division; Thomas J Dellamaria, Vice President Production & Manufacturing; Frank Sibley, Group Vice President. Copyright 1987 by Reed Publishing USA, a division of Reed Holdings Inc; Saul Goldweitz, Chairman; Ronald G Segel, President and Chief Executive Officer, Robert L Krakoff, Executive Vice President. Circulation records maintained at Cahners Publishing Co, 270 St Paul St, Denver, CO 80206. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send address changes to EDN, 270 St Paul St, Denver, CO 80206.

How to be perfect to a fault.

Get your product to market faster. Save weeks debugging each prototype circuit board. Immediately.

What a faultless package: Fluke's 9000 Series of micro-based *hardware* debuggers. Plus the *free* troubleshooting training. And Fluke support when and where you need it.

A package never before offered.

So you can start testing your prototype board on Monday, learn how to automate your verification process on Tuesday, and look like a saint on Wednesday.

And to make it even more miraculous, put Fluke on trial for 30 days and see how many faults you can find. On us.

Just call the toll-free Fault-Line and get the whole story:

- Your choice of three 9000 Series Hardware Debuggers. From Fluke, the world leader in emulative board testing. Fully-programmable to low-cost models. Even an IEEE-488 model.
- Fast built-in tests discover hardware faults.
- Exercise all data paths, without writing a line of code.
- Support for over 50 microprocessors.
- New expanded fault coverage.
- Assure testability in manufacturing and service.

From the moment you plug the interface pod into the microprocessor socket, you'll save time, money and deadlines.

And become faultless in the eyes of man.

Call the Fault-Line For 30-Day Free Trial
1-800-44-FLUKE Ext. 201

FLUKE®

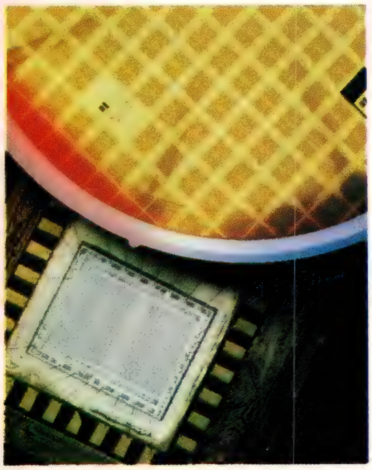
IN THE U.S. AND NON-EUROPEAN COUNTRIES: John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206. Sales: (206) 356-5400. Other: (206) 347-6100.
EUROPEAN HEADQUARTERS: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven. The Netherlands, (040) 458045, TLX: 51846.
©Copyright 1986 John Fluke Mfg. Co., Inc: All rights reserved. Ad No. 1010-9000

CIRCLE NO 163

Continued from page 5

EDN

March 18, 1987



***CMOS FIFO buffers** are employing memory architectures to achieve high capacities and fast data rates. Furthermore, the devices don't exhibit the ripple-through delays that contribute to the input/output latency time inherent in shift-register versions (pg 65).*

TECHNOLOGY UPDATE

Memory-based CMOS FIFO buffers sport large capacities, rival the speed of bipolars 65

The latest generation of 9-bit-wide, memory-based FIFO buffers allows you to implement data-rate buffers or data-delay lines as deep as 4096 words with a single chip.—*Peter Harold, European Editor*

Tools help you retain the advantages of using breadboards in gate-array design 81

When you've considered the various approaches to developing a gate array, you may have deemed the use of a breadboard as impractical. Now, however, with careful selection of device types and helpful design tools, you can reap the benefits that creating a breadboard still confers.—*David Shear, Regional Editor*

Electro/87 and Mini/Micro Northeast programs will examine divergent topics 95

Electro/87 and Mini/Micro Northeast will run from April 7 to 9 at the Jacob Javits Convention Center in New York City.—*Tom Ormond, Senior Editor*

PRODUCT UPDATE

Enhanced PC-compatible CAE workstation 103
Single-chip data-acquisition system 104
PC-board-manufacturing workstation 106
STD Bus-based IBM PC-compatible system 108
80186-based data-acquisition board 111
Digital meter 115
Low-cost trackball 116
Cartridge-tape drive 118

DESIGN IDEAS

VME system controller reduces parts count 203
Circuit vocalizes hex code for 4-bit input 204
Video IC extracts timing waveforms 208
Nested functions transform filter roots 210
Circuit debounces pushbutton switch 212

Continued on page 9

Advertising and editorial offices: 275 Washington St, Newton, MA 02158. Phone (617) 964-3030. Subscription offices: 270 St Paul St, Denver, CO 80206. Phone (303) 388-4511. EDN is circulated without charge to those qualified. Subscription to others: US, $95/year, $6/copy; Canada and Mexico, $110/year, $8/copy; Europe Air Mail, $135/year, $10/copy; all other nations surface mail, $135/year, $10/copy; all other nations Air Mail, $200/year. Special issue prices may vary. Send requests for qualification forms and/or change of address to subscription office.
© 1987 by Reed Publishing USA, Division of Reed Holdings Inc. All rights reserved.

KEITHLEY ON SEMICONDUCTOR MEASUREMENTS:

PROVE IT.

For difficult semiconductor measurements, you need assurance that your instrumentation can correctly verify process, wafer, or device specifications. Not being sure can reduce confidence in your test results.

These difficult semiconductor measurements need a broad line of instruments specifically designed to solve semiconductor source, measure, and connect problems. Keithley has them. Our evidence:

SOURCING INSTRUMENTS

All our low-noise current, voltage and crossover sources have built-in memory so you can program a sequence of levels. Some also feature sensitivity to below 1 pA; others go to 1 A at 100 V, or 10 A at 10 V.

MEASURING INSTRUMENTS

Measure currents from 10 aA (10^{-17}) to 10 A, and voltages from 10 nV to 1 kV. Up to 6½ digit resolution and speeds up to 100 kHz at 16 bits. Measure resistances from 10 μΩ to 10 PΩ (10^{16} Ω). Our measuring instrument line also includes an IEEE-488 thermometer and 1.3-GHz counter/timer.

TWO NEW CV METERS

One is a 100 kHz/1 MHz CV analyzer with sensitivity better than 1 fF, an extended range option to 20 nF, powerful math functions and built-in cable correction and plotter drive. On-board features also include low 15 mV rms drive voltage, 4½ digit resolution and internal memory to store front panel setups. The other is a quasistatic CV meter using a new technique to directly correct for background currents and help you find the right sweep rate faster.

CONNECTING INSTRUMENTS

Programmable switches with 17 different cards to choose from, some specified to 500 MHz. Other capabilities include matrix, picoamp sensitivity, and up to 10^{15} Ω isolation.

WHAT WE MAKE WORKS TOGETHER EASILY

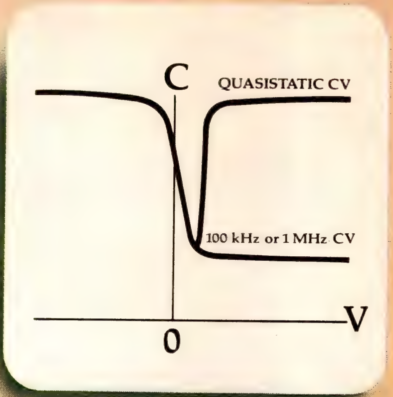
Not only do these products perform individually, they are designed to be used together in a variety of combinations. Evidence: we give you three ways to measure Hall effect. First, a plug-in card with all needed sensitive amplifiers, cables, and switching for use with our low-cost programmable switch. Second, an instrument package with instructions on how to make your own system; or third, a complete turnkey system.

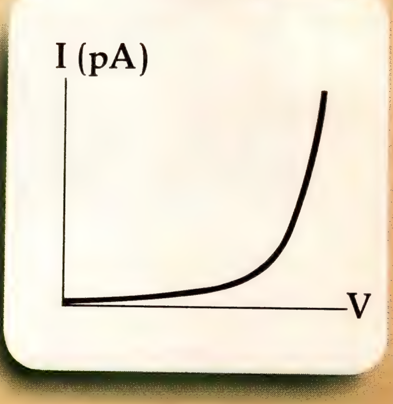
All our products feature compatible hardware, are easy to set up, and use a language common to other Keithley instruments. That saves you from learning a new language for every new instrument. Further, the telephone assistance provided by the application engineers at our Information Center helps you find out specifically how to use Keithley instruments to solve your unique semiconductor measurement problems.

We've stated that Keithley has the ability to do semiconductor measurements. Now it's time to prove it.

Call the Information Center at (216) 248-0400, or write Keithley Instruments, 28775 Aurora Road, Cleveland, Ohio 44139.

The best proof of our leadership in sensitive instruments is the fact that we've specialized in them for the last 40 years. But the past is prologue. Today we make the total spectrum of semiconductor test instruments which SOURCE, MEASURE, and CONNECT signals in semiconductor research, design and test labs.





SOURCE • MEASURE • CONNECT

KEITHLEY

CIRCLE NO 148

Continued from page 7

EDN

March 18, 1987

EDITORIAL 57

Changes in sales techniques are resulting in lower prices for pc-board layout packages.

NEW PRODUCTS

Components & Power Supplies 218
Computers & Peripherals 228
Integrated Circuits 240
Test & Measurement Instruments 252
CAE & Software Development Tools 258

PROFESSIONAL ISSUES 276

Putting creativity to work.—*Deborah Asbrand, Associate Editor*

LOOKING AHEAD 291

Future of supercomputers lies in parallel processing . . . Power ICs: one hot hitter in US semiconductor slump.

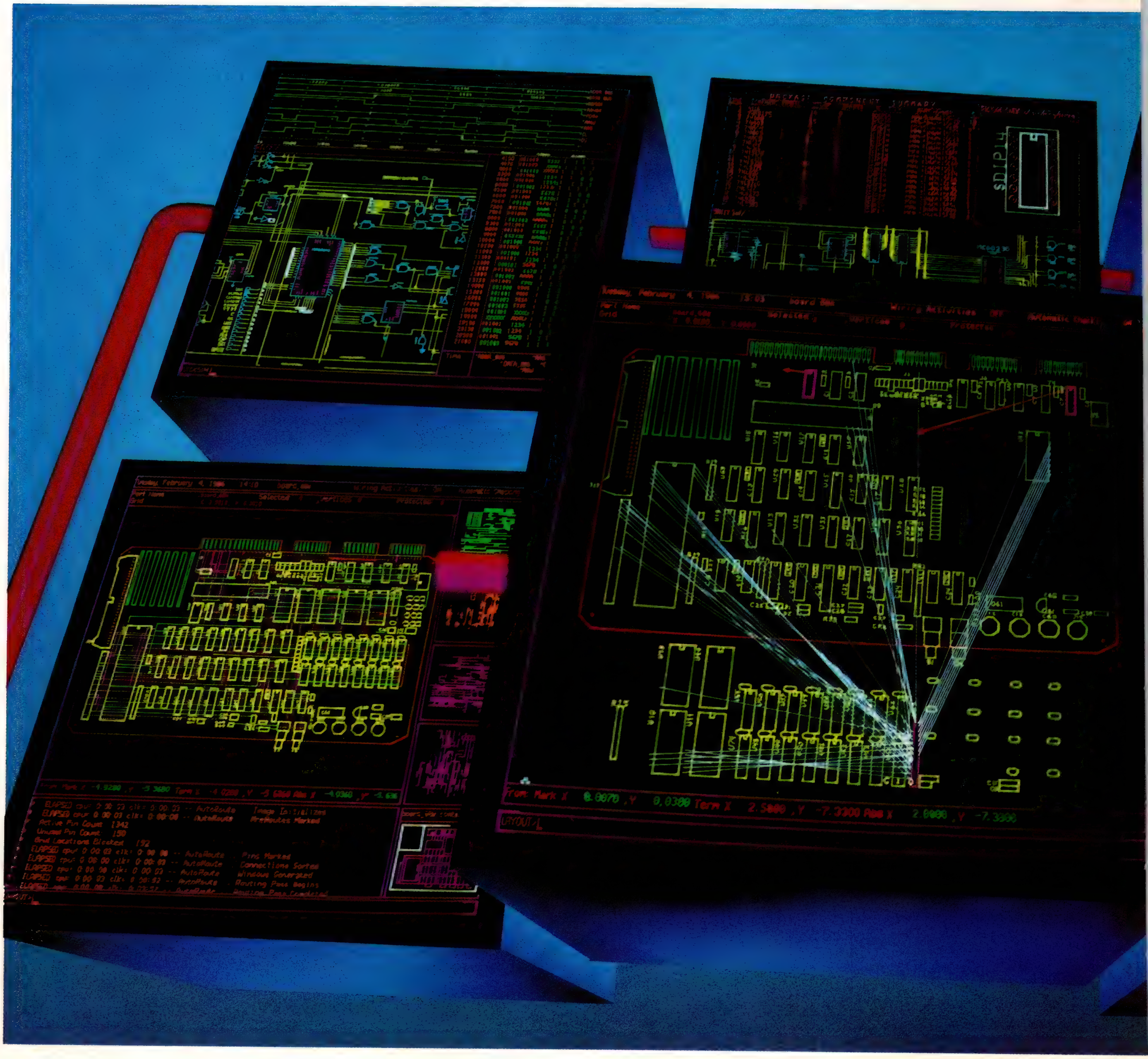
DEPARTMENTS

News Breaks 19
News Breaks International 22
Signals & Noise 30
Calendar 42
Readers' Choice 124
Leadtime Index 130
Literature 270
New Books 274
Business/Corporate Staff 280
Career Opportunities 282
Advertisers Index 290

VP/Publisher
F Warren Dickson
VP/Associate Publisher/Editorial Director
Roy Forsberg
Editor
Jonathan Titus
Managing Editor
Rick Nelson
Assistant Managing Editor
Joan Morrow
Special Projects
Gary Legg
Home Office Editorial Staff
275 Washington St, Newton, MA 02158
(617) 964-3030
Tom Ormond, *Senior Editor*
Deborah Asbrand, *Associate Editor*
Joanne Clay, *Associate Editor*
Tarlton Fleming, *Associate Editor*
Eva Freeman, *Associate Editor*
Clare Mansfield, *Associate Editor*
Dave Pryce, *Associate Editor*
Charles Small, *Associate Editor*
George Stubbs, *Associate Editor*
Chris Terry, *Associate Editor*
Jim Wiegand, *Associate Editor*
Valerie Lauzon, *Staff Editor*
Helen McElwee, *Staff Editor*
Cynthia B Rettig, *Staff Editor*
Steven Paul, *Production Editor*
Editorial Field Offices
Margery S Conner, *Regional Editor*
Newbury Park, CA: (805) 499-7901
Bob Cushman, *Special Features Editor*
Port Washington, NY: (516) 944-6524
Chris Everett, *Regional Editor*
San Jose, CA: (408) 296-0868
Steven H Leibson, *Regional Editor*
Boulder, CO: (303) 494-2233
J D Mosley, *Regional Editor*
Arlington, TX: (817) 465-4961
David Shear, *Regional Editor*
San Jose, CA: (408) 296-0868
Maury Wright, *Regional Editor*
San Diego, CA: (619) 748-6785
Peter Harold, *European Editor*
0603-630782
(St Francis House, Queens Rd,
Norwich, Norfolk NR1 3PN, UK)
Contributing Editors
Robert Pease, Bob Peterson, Don Powers,
Bill Travis
Editorial Services
Kathy Leonard, *Office Manager*
Loretta Curcio, Nancy Weiland,
Sharon Gildea
Art Staff
Kathleen Ruhl, *Art Director*
Chin-Soo Chung, *Graphic Designer*
Deborah Queally, *Graphic Designer*
Production/Manufacturing Staff
William Tomaselli, *Production Supervisor*
Donna Pono, *Production Manager*
Beth Ann Cooper, *Production Assistant*
Andrew A Jantz, *Production Assistant*
Diane Malone, *Composition*
Graphics Director
Norman Graf
VP/Production/Manufacturing
Wayne Hulitzky
Director of Production/Manufacturing
John R Sanders
Director of Research
Deborah Virtue
Marketing Communications
Janice Molinari, *Manager*
Jennifer Ware, *Communications Manager*
John Bartlett, *Marketing Projects Manager*
Corie Rand, *Promotion Coordinator*
Anne Foley, *Promotion Assistant*

Cahners Publishing Company ☐ A Division of Reed Publishing USA ☐ Specialized Business and Consumer Magazines for Building & Construction ☐ Interior Design ☐ Electronics & Computers ☐ Foodservice & Lodging ☐ Manufacturing ☐ Book Publishing & Libraries ☐ Medical & Health Care ☐ Child Care/Development

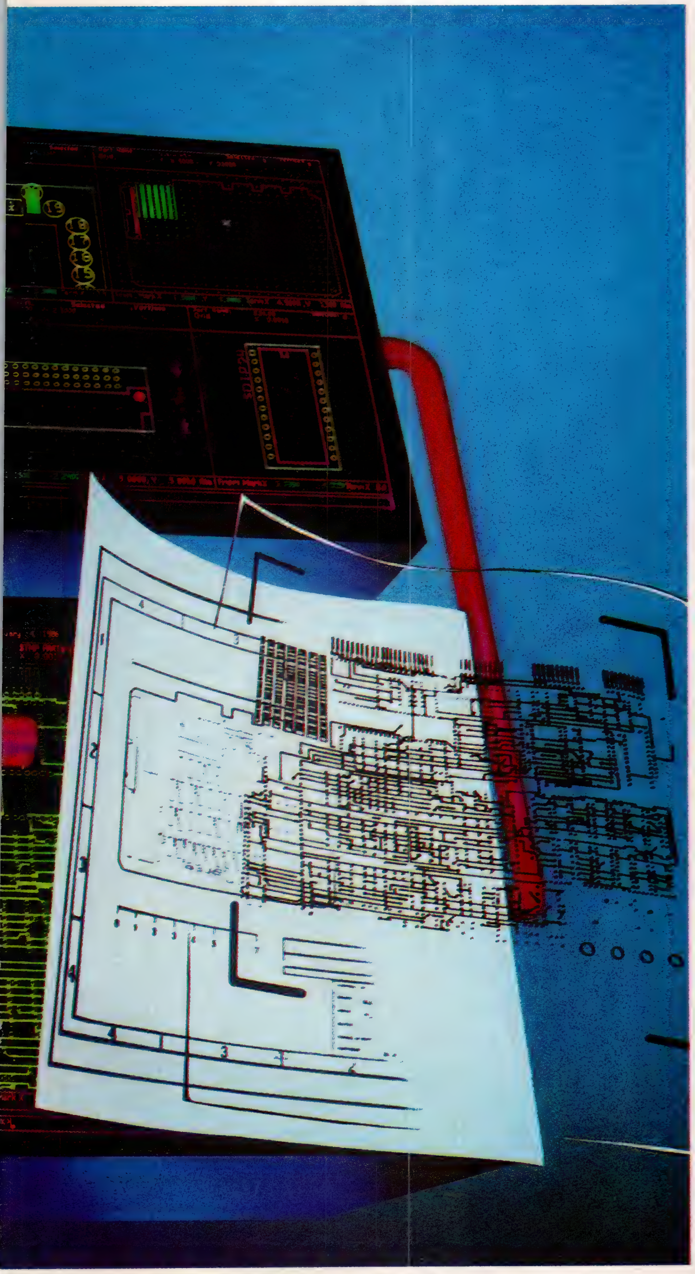
Only Mentor Graphics puts PCB layout where it belongs.



Until now, printed circuit board layout was an isolated process: done on a special-purpose workstation at the "back end" of the design effort. But Mentor Graphics saw it a different way. Since PCB layout brings together all the elements created by "front end" CAE tools, it should be integrated with those tools.

So, PCB layout is now an integral part of the powerful Mentor Graphics IDEA Series™ of Engineering Workstations.

At last, PCB layout resides in a CAE network that also includes hierarchical schematic capture, as well as logic and analog simulation. All linked in an environment that permits fast, simple data sharing for greater productivity.



As for the tools themselves, a very fast and efficient routing system optimizes board usage and minimizes manufacturing overhead. Now you can do both automatic and interactive fine line routing on even the most complex multi-layer boards. A double-sided placement editor presents a complete view of components on either side of the board under design.

And you have the ability to work with almost any type of component package to optimize your design to meet current market requirements.

Also, our PACKAGE tool bridges, at long last, the gap between EE and PCB designers. Any electronic design is automatically translated into proper component packaging.

And when you're ready to go to manufacturing, we provide Gerber output, drill output and master drawing output. You can preview, right on the CRT, the final artwork, exactly as it will appear when completed. No waiting. No surprises.

Finally, we've put PCB layout in an open system. With an open database and ASCII files, you've got a clear path to other systems, such as automated manufacturing, quality control and MRP.

It's all part of a vision unique to Mentor Graphics, the leader in design automation. Let us show you where this vision can take you.

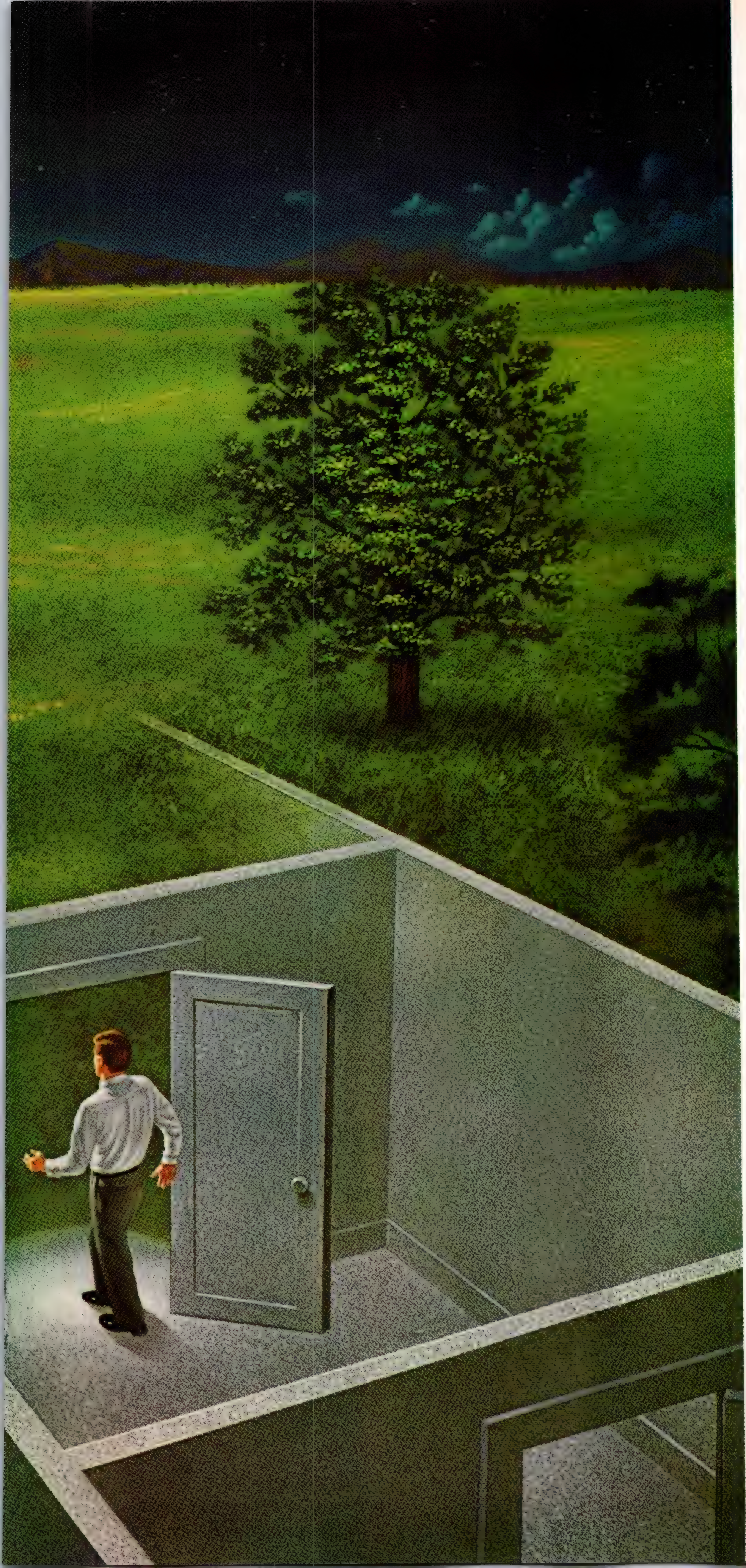
Call us for an overview brochure and the number of your nearest sales office.

Bracknell, England; Phone 0344-482828 **Livingston, Scotland;** Phone 0506-412222 **Munich, West Germany;** Phone 089-57096-0 **Wiesbaden, West Germany;** Phone 06121-371021 **Paris, France;** Phone 04-560-5151 **Milan, Italy;** Phone 02-824-4161 **Spanga, Sweden;** Phone 0468-750-5540 **The Hague, Netherlands;** Phone 070-624-461 **Tokyo, Japan;** Phone 03-589-2820 **Hong Kong;** Phone 0852-566-5113 **Singapore;** Phone 0779-1111 **Middle East, Far East, Asia, South America;** Phone 503-626-7000 **Mississauga, Ontario;** Phone 416-279-9060

Mentor Graphics™

Advanced Micro Devices • **Bruxelles** (32-2) 771 99 93 • **Hannover** area (49-5143) 50 55
Hong Kong (852-3) 695377 • **London** area (44-4862) 22121 • **Manchester** area (44-925) 828008
Milano (39-2) 3533241 • **München** (49-89) 4114 0 • **Osaka** (06-243) 3250 • **Paris** (33-1) 45600055
Stockholm (46-8) 733 03 50 • **Stuttgart** (49-711) 62 33 77 • **Tokyo** (81-3) 345 8241
Latin America, Fort Lauderdale, Florida/U.S.A. Tel: (305) 484-8600 Tlx: (510) 955-4261 amd ftl

© Advanced Micro Devices, Inc. 1987



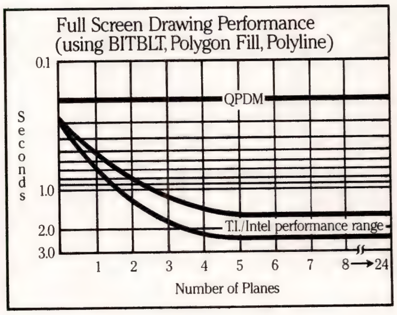
Don't let reality stop you.

Grab a pad and get to work on tomorrow.

That's how we designed the Am95C60 Quad Pixel Dataflow Manager, a CMOS graphics coprocessor that proves "high performance graphics" is no longer a contradiction in terms.

With a polyline draw speed of 110,000 vectors per second, a BITBLT transfer of 55ns per pixel, and a polygon fill of 20ns per pixel, QPDM can change a screen faster than the speed of thought. (It can redraw a 1K X 1K screen in 0.2 seconds.)

Besides being powerful, this animal is highly trained. The instruction set for full graphics and text primitives is already on the chip. There aren't any extra programming hurdles to slow it down.



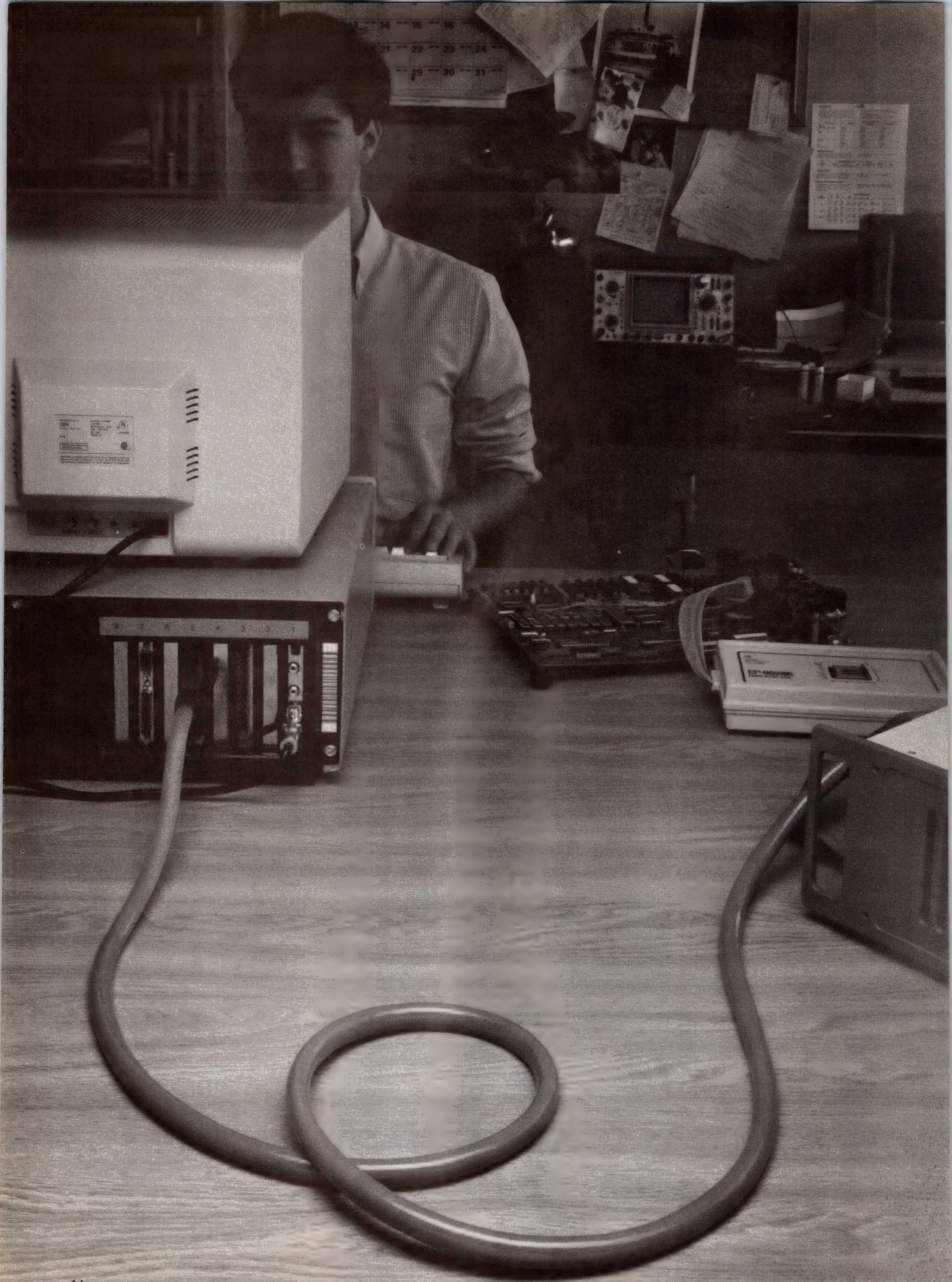
Each QPDM addresses four planes. It's cascadable, too. With no degradation in performance. And it can deliver all the color you need.

Get ahead of the market by designing it in now. Find out more about QPDM and QPDM seminars. Just call or write the sales agent near you. Then get to work on designing the future.

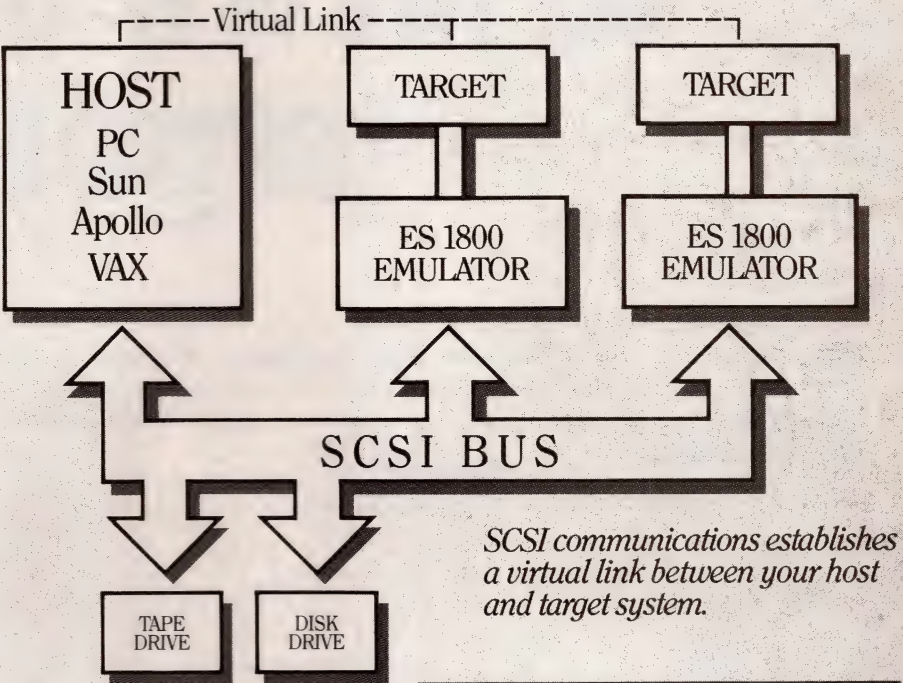
Advanced Micro Devices

For more information, contact the sales agent nearest you or write the word "QPDM" on your letterhead and mail to Advanced Micro Devices, Mail Operations,
P.O. Box 4, Westbury-on-Trym,
Bristol BS9 3DS, United Kingdom.

CIRCLE NO 152



Data shouldn't take 30 minutes to travel two and a half feet.



SCSI communications establishes a virtual link between your host and target system.

Instead of killing time, you could be killing bugs. Because Applied Microsystems now offers a high speed emulator interface to rescue debug sessions bogged down by data throughput. It's the industry standard architecture called SCSI. The bus that can squeeze five-minute transfers into 10 seconds.

Downloading and transferring data at speeds up to 1.5 Mbytes per second over a SCSI bus gives you a powerful advantage. Your information is now moving up to 30 times faster than you're used to, creating a virtual link between your host and target system.

That advantage becomes even more important when you're working with big blocks of code as you would on a 68020 or 80286 design.

HOSTS	OPERATING SYSTEMS	TARGETS	LANGUAGES	TOOLS
VAX	VMS	8051	C	Assemblers
MicroVAX	ULTRIX	8048 family	Pascal	Linkers
UNIX® workstations · Apollo · Sun · IBM AT	UNIX	8080, 8085, 8086/88, 80186/188 and 80286	FORTRAN	Locaters
MS-DOS workstations · PC · PC XT · PC AT · Compatibles	XENIX	68HC11, 6800/2/8, 6809/9E, 68000/8/10 and 68020	PL/M	Compilers
	MS-DOS	Z80, MK3880/4 and Z8001/2/3	Assembler	Symbolic debuggers
		NSC-800	Jovial	Source level debuggers
				Emulators

A stand-alone or host-control system of fully integrated debug tools built on high performance emulation.

With SCSI, your development environment takes on the dimension of immediacy. You have control and visibility without waiting. And true interactive debugging becomes possible for the first time.

SCSI unites real-time emulation with source level debugging.

Thanks to SCSI's tremendous speed, the events of high performance emulation are transported to your host as they happen. Trace information appears on your computer in seconds, not minutes. And through VALIDATE™ you can immediately debug in your source level language.

SCSI supports up to eight devices to achieve various multi-user or multi-instrument configurations. Combined with the full real-time capabilities of Applied Microsystems in-circuit emulation, now you can easily assemble a development system that's phenomenally fast and functional.

Call for the facts that speak for themselves.

Find out why Applied Microsystems emulation with SCSI is the most painless way to begin a design project and finish it on schedule. For full details, call 1-800-426-3925 toll-free and ask for Telemarketing. In Washington state call (206) 882-2000. Or write to Applied Microsystems, P.O. Box 97002, Redmond, WA 98073-9702.

In Europe contact Applied Microsystems Corporation Ltd., Chiltern Court, High Street, Wendover, Aylesbury, Bucks, HP22 6EP, United Kingdom. Call 44-(0)-296-625462.

UNIX is a registered trademark of AT&T.

Applied
Microsystems
Corporation

CIRCLE NO 151

101 ways to hit a moving target.

PAL Family	Generic Part Number	Std MIL Drawing	Replacement JAN Specification Part #
Small 20 Combinatorial	PAL10H8MJ883B	8103501RA	M38510/50301BRXA
	PAL10H8ML883B	81035012C	M38510/50301B2XC
	PAL10H8MF883B	8103501SC	–
	PAL12H6MJ883B	8103502RA	M38510/50302BRXA
	PAL12H6ML883B	81035022C	M38510/50302B2XC
	PAL12H6MF883B	8103502SC	–
	PAL14H4MJ883B	8103503RA	M38510/50303BRX
	PAL14H4ML883B	81035032C	M38510/50303B2X
	PAL14H4MF883B	8103503SC	–
	PAL16H2MJ883B	8103504RA	M38510/50304BRX
	PAL16H2ML883B	81035042C	M38510/50304B2X
	PAL16H2MF883B	8103504SC	–
	PAL16C1MJ883B	8103505RA	M38510/50305BRX
	PAL16C1ML883B	81035052C	M38510/50305B2X
	PAL16C1MF883B	8103505SC	–
	PAL10L8MJ883B	8103506RA	M38510/50306BRX
	PAL10L8ML883B	81035062C	M38510/50306B2X
	PAL10L8MF883B	8103506SC	–
	PAL12L6MJ883B	8103507RA	M38510/50307BRX
	PAL12L6ML883B	81035072C	M38510/50307B2X
	PAL12L6MF883B	8103507SC	–
	PAL14L4MJ883B	8103508RA	M38510/50308BRX
	PAL14L4ML883B	81035082C	M38510/50308B2X
	PAL14L4MF883B	8103508SC	–
	PAL16L2MJ883B	8103509RA	M38510/50309BRX
	PAL16L2ML883B	81035092C	M38510/50309B2X
	PAL16L2MF883B	8103509SC	–
Medium 20A	PAL16L8AMJ883B	8103607RA	M38510/50401BRX
	PAL16L8AML883B	81036072C	M38510/50401B2X
	PAL16L8AMW883B	8103607SA	–
	PAL16R8AMJ883B	8103608RA	M38510/50402BRX
	PAL16R8AML883B	81036082C	M38510/50402B2X
	PAL16R8AMW883B	8103608SA	–
	PAL16R6AMJ883B	8103609RA	M38510/50403BRX
	PAL16R6AML883B	81036092C	M38510/50403B2X
	PAL16R6AMW883B	8103609SA	–
	PAL16R4AMJ883B	8103610RA	M38510/50404BRX
	PAL16R4AML883B	81036102C	M38510/50404B2X
	PAL16R4AMW883B	8103610SA	–
Medium 20A-2 ½ Power	PAL16L8A-2MJ883B	8103611RA	M38510/50407BRX
	PAL16L8A-2ML883B	81036112C	M38510/50407B2X
	PAL16L8A-2MW883B	8103611SA	–
	PAL16R8A-2MJ883B	8103612RA	M38510/50408BRX
	PAL16R8A-2ML883B	81036122C	M38510/50408B2X
	PAL16R8A-2MW883B	8103612SA	–
	PAL16R6A-2MJ883B	8103613RA	M38510/50409BRX
	PAL16R6A-2ML883B	81036132C	M38510/50409B2X
	PAL16R6A-2MW883B	8103613SA	–
	PAL16R4A-2MJ883B	8103614RA	M38510/50410BRX
	PAL16R4A-2ML883B	81036142C	M38510/50410B2X
	PAL16R4A-2MW883B	8103614SA	–

Military Package Designators:

R = 20 lead ¼ x 1¹⁄₁₆ dual-in-line
S = 20 lead ¼ x ½ Flatpack
2 = 20 Terminal .350 x .350 Leadless Chip Carrier
K = 24 lead ⅜ x ⅝ Flatpack
L = 24 lead ¼ x 1¼ Dual-in-Line
3 = 28 Terminal .450 x .450 Leadless Chip Carrier

MMI Package Designators:

J = Ceramic DIP
F = Bottom Brazed Flatpack
L = Leadless Chip Carrier
W = Cerpak
JS = 24 pin Cerdip

CIRCLE NO 62

Now that the DOD is rethinking the order of its mil spec standards, which one should you shoot for?

Well, when it comes to military PAL® devices, you can't miss. Simply set your sights on Monolithic Memories.

You see, we have more PAL devices qualified to the highest military standards, JAN38510 and the Standard Military Drawing Program, than anybody else. (See list below.)

Even our newest PAL devices, from high-speed ECL to low-power CMOS, are already slated for Standard Military Drawing release.

So whether the DOD moves its standards or leaves them right where they are, you'll be right on target.

For a copy of our new Military Products Short Form Catalog, call your local Monolithic Memories representative or qualified military distributor.

Monolithic Memories, Military Products Division, 2175 Mission College Blvd., Santa Clara, CA 95054. (800) 222-9323.

Monolithic Memories MMI

PAL Family	Generic Part Number	Std MIL Drawing	Replacement JAN Specification Part #
Medium 24A	PAL20L8AMJS883B	8412901LA	M38510/50501BJX
	PAL20L8AML883B	84129013C	M38510/50501B3X
	PAL20L8AMW883B	8412901KA	–
	PAL20R8AMJS883B	8412902LA	M38510/50502BJX
	PAL20R8AML883B	84129023C	M38510/50502B3X
	PAL20R8AMW883B	8412902KA	–
	PAL20R6AMJS883B	8412903LA	M38510/50503BJX
	PAL20R6AML883B	84129033C	M38510/50503B3X
	PAL20R6AMW883B	8412903KA	–
	PAL20R4AMJS883B	8412904LA	M38510/50504BJX
	PAL20R4AML883B	84129043C	M38510/50504B3X
	PAL20R4AMW883B	8412904KA	–
Medium 24XA Exclusive OR	PAL20L10AMJS883B	8412905LA	–
	PAL20L10AML883B	84129053C	–
	PAL20X8AMJS883B	8412906LA	–
	PAL20X8AML883B	84129063C	–
	PAL20X10AMJS883B	8412907LA	–
	PAL20X10AML883B	84129073C	–
	PAL20X4AMJ883B	8412908LA	–
	PAL20X4AML883B	84129083C	–
Medium 20A-4 ¼ Power	PAL16L8A-4MJ883B	8506501RA	–
	PAL16L8A-4ML883B	85065012C	–
	PAL16R8A-4MJ883B	8506502RA	–
	PAL16R8A-4ML883B	85065022C	–
	PAL16R6A-4MJ883B	8506503RA	–
	PAL16R6A-4ML883B	85065032C	–
	PAL16R4A-4MJ883B	8506504RA	–
	PAL16R4A-4ML883B	85065042C	–
Medium 20B	PAL16L8BMJ883B	8515501RA	–
	PAL16L8BML883B	85155012C	–
	PAL16R8BMJ883B	8515502RA	–
	PAL16R8BML883B	85155022C	–
	PAL16R6BMJ883B	8515503RA	–
	PAL16R6BML883B	85155032C	–
	PAL16R4BMJ883B	8515504RA	–
	PAL16R4BML883B	85155042C	–
Medium 20B-2 ½ Power	PAL16L8B-2MJ883B	8515505RA	–
	PAL16L8B-2ML883B	85155052C	–
	PAL16R8B-2MJ883B	8515506RA	–
	PAL16R8B-2ML883B	85155062C	–
	PAL16R6B-2MJ883B	8515507RA	–
	PAL16R6B-2ML883B	85155072C	–
	PAL16R4B-2MJ883B	8515508RA	–
	PAL16R4B-2ML883B	8515508SA	–

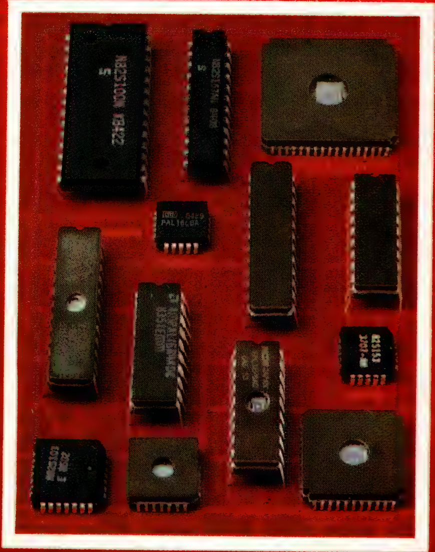
PAL is a registered trademark of Monolithic Memories.

©1987, Monolithic Memories.

CIRCLE NO 62

ZL30A

Power in design
Speed in production



Stag's ZL30A offers total PLD programming support

Stag Microsystem's model ZL30A is the first dedicated Logic Programmer of its kind that not only supports programming of PLDs, EPLDs, and GALs*, in a variety of 20, 24, 28 and 40 pin DIP, but also supports programming of the latest surface mounted PLCC/LCC devices.

Stag's ZL30A contains features that have made it the industry standard in both engineering and production environments. Salient among these are: ●Powerful easy-to-use editing capability ●Super fast programming speed ●Stand alone or remote control operation ●Comprehensive device library ●Handler interface capability to support DIP or PLCC/LCC devices ●I/O formats include JEDEC, Signetics and X-Plot ●Compatible with CUPL* software compiler ●RS232C, IEEE-488 and handler control interface ports standard ●Expansion modules accommodate 40 pin DIP and a range of surface mounted devices ●Stringent in-program checks including continuity and connect tests are automatically performed to guarantee error free stand alone or handler operation ●Supports Test Vectors ●Turn-Key handler interface kits ●Worldwide sales and service support.

Stag Electronic Designs Ltd., Stag House
Tewin Court, Welwyn Garden City, Herts AL71AU
Tel: (0707)332148 Telex: 8953451

stag

Sophisticated systems for the discerning engineer

*GAL is a trademark of the Lattice Corp.
*CUPL is a trademark of Assisted Technology.

NEWS BREAKS

EDITED BY JOAN MORROW

SINGLE-CHIP DISK CONTROLLER SUPPORTS ESDI

The Am9590 from Advanced Micro Devices (Sunnyvale, CA, (408) 732-2400) is a single-chip hard-disk controller that supports the emerging Enhanced Small Disk Interface (ESDI) at data rates to 15 MHz. The device can control any combination of as many as four hard- or floppy-disk drives. The characteristics of each drive are independently user programmable. Two on-chip sector buffers, each with 512 bytes max, support zero-sector interleaving to increase system throughput. The Am9590 is packaged in a 68-pin leadless chip carrier and costs $69.95 (100).—David Shear

SOFTWARE TOOLS LET MACINTOSH CONTROL IBM PC I/O BOARDS

Now you can use your Macintosh Plus computer and MacBus expansion unit to control Analog Devices' RTI-800 Series analog and digital I/O expansion cards. The MacBus/RTI-800 Series software from National Instruments (Austin, TX, (512) 250-9119) lets you program RTI-800 cards using Microsoft Basic, Magamax C, or LabView. If you use C or Basic, the local MacBus μP interprets command strings to perform data-acquisition and -control I/O functions. Using LabView—National Instruments' graphical programming language for automatic test and measurement—the RTI-800 boards appear to be electronically wired into a LabView block diagram, and LabView performs all communication tasks. For $195, you get the software and application examples written in C and LabView.—J D Mosley

DIGITAL WORD GENERATOR OPERATES TO 250 MHz OVER 32 CHANNELS

Look for Interface Technology (Glendora, CA) to introduce a 128-channel, 62.5-MHz digital word generator next month. You can operate the generator in a 32-channel mode at data rates to 250 MHz. You can program output edges with 50-psec resolution and output amplitudes with 10-mV resolution.—Chris Everett

OPTICAL SCANNER AND LASER PRINTER SUIT DESKTOP PUBLISHING

Two new products from Hewlett-Packard Co (Palo Alto, CA) underscore the company's continued interest in desktop publishing. The $1495 ScanJet optical scanner features user-selectable 38- to 300-dots/in. resolution and three scanning modes: binary, dithered, and gray scale. You use binary image scanning on line art and text, dithered scanning (similar to half-tone representation) on photographs, and gray-scale scanning for high-quality photographic reproduction. The scanner recognizes 16 gray shades. A $495 interface-card and software package links ScanJet to IBM PC and compatibles. The $2495 LaserJet Series II laser printer includes all of the features of the company's earlier $3995 LaserJet Plus model, plus a few more. Based on the Canon LBP-SX print engine, the laser printer incorporates a new paper path that emits copies face down, enabling the printer to deliver multiple-page documents in the correct order. The base printer includes 512k bytes of memory. A $495 1M-byte expansion board allows the printer to create full-page, 300-dots/in. graphics.—Steven H Leibson

NEW 32-BIT CPU CHIP OFFERS RISC-LIKE ARCHITECTURE

By late 1987 or early '88, Advanced Micro Devices Inc (Sunnyvale, CA) hopes to be in the 32-bit μP market with its Am29000 CMOS CPU chip. The streamlined-instruction processor (SIP) will provide a set of simple instructions that take advantage of the chip's RISC-like architecture. AMD plans to offer chips that operate at 25 MHz, which would sustain a rate of 17 MIPS. The chip will contain 192 general-purpose registers, a 64-entry memory-management unit, and a 512-byte cache.—Jon Titus

NEWS BREAKS

65×100-mm FACSIMILE MODEM BOARD RUNS AT 14,400 BPS

The $255 HF144 facsimile modem from Emulex (Costa Mesa, CA, (714) 662-5600) is 50% faster than previous fax modems, yet fits in the same 65×100-mm form factor. It operates at 14,400, 12,000, 9600, 7200, 4800, 2400, and 300 bps, and it uses trellis-coded modulation at 14,400 and 12,000 bps in accordance with CCITT V.33. At 9600 bps, you can choose between V.29 and TC96 modes. V.29 does not specify trellis coding; TC96 implements it in accordance with V.32. Trellis-coded modulation results in improved signal quality and refers to the visual form the data takes in an eye-pattern display.—Margery S Conner

EVALUATION MODULE LETS YOU TEST M68HC05 PROTOTYPE DESIGNS

The $500 M68HC05 Evaluation Module from Motorola (Austin, TX, (512) 440-2035) is a board that emulates all of the essential timing and I/O circuitry of MC68HC05C4/C8 μCs. It allows you to design, debug, and evaluate hardware and software designs for use with those μCs and with future members of the M68HC05 family. Communicating via an RS-232C port, the module is compatible with IBM PCs, VAXs, PDP-11s, and any Motorola development system. The module includes jumper-selectable options such as IRQ sensitivity and clock input selection. An EEPROM μC programmer enables you to check, erase, program, verify, and copy the contents of DIP or PLCC μCs.—J D Mosley

CERTIFIED BEHAVIORAL MODELS SIMULATE 74AS8800 ICs PRECISELY

Texas Instruments (Dallas, TX) has certified Quadtree's (Bridgewater, NJ) behavioral models of the TI SN74AS8800 chip set. To certify the behavioral models, Texas Instruments verified that the models implement all functional and timing characteristics of the physical ICs.

The SN74AS8800 chip set consists of nine support chips for TI's 32-bit μP. You can use these models to design and debug, in software, a μP-based system or a single-board computer. The chip set includes such devices as a 32-bit multiplier/accumulator, a floating-point processor, and 32-bit shifters. The behavioral models cost $500 to $1500; a set of all nine models costs $7200.—Eva Freeman

DATA-ACQUISITION BOARD SPEEDS WAVEFORM DATA STORAGE

Functioning as either a stand-alone system or as an enhancement to the manufacturer's Soft500 data-acquisition and -control program, the Real Time Monitor and Direct Storage System (RTMDS) from Keithley Instruments (Cleveland, OH, (216) 248-0400) continuously sends data to your PC's floppy or hard disk at speeds as fast as 5000 samples/sec, while maintaining a real-time waveform display on your PC's monitor. By performing the plotting functions in hardware, the $1200 RTMDS frees your PC for other tasks. When used in conjunction with Soft500, the program runs as much as 10 times faster. The RTMDS provides as many as 16 channels of direct data storage, simultaneous display of as many as eight channels, smooth scrolling, and a triggered sweep-display mode. —J D Mosley

INDUSTRY-STANDARD FIFO MEMORY COMES IN LOW-POWER VERSION

A low-power FIFO memory that is pin-for-pin compatible with the IDT7201 and the MK4501 is available from Mosel (Sunnyvale, CA, (408) 733-4556). The MS7201 is a 512×9-bit FIFO memory that consumes 10 μA during data retention and 40 mA maximum while operating. The MS7201 comes in 50- to 120-nsec versions in 28-pin plastic DIPs for $13 to $26 (100).—David Shear

Why fill your digital delay design with unnecessary components, when you can have all the capability you need in one small, low-cost IC?

TRW LSI Products Division, the industry leader in high performance digital signal processing products, gives designers an edge with the TDC1011. The TDC1011 is a high-speed, 8-bit wide shift register, programmable to any length between 3 and 18 stages. It operates at an 18MHz shift rate (56ns worst case), is TTL compatible, and dissipates a low 750mW.† The TDC1011 operates from a single +5V power supply and is available in a 24-lead DIP.

The beauty of the TDC1011 is that this single chip performs the same functions that would require as many as 18 alternative chips — instead of 18 shift registers, you can use just one in a variety of digital delay applications. This translates into lower component costs, less board space and reduced power dissipation. Built with TRW's OMICRON-B™ one-micron bipolar process, the TDC1011 provides the system designer with a unique variable delay capability at video speed.

You can use the TDC1011 for telecom, sonar, radar, CAT scanners, computer graphics, TV special effects, and a host of other digital delay applications. And, as with all of our products, the TDC1011 is backed by our extensive network of in-house and field applications engineers, application notes and our full line VLSI DATA BOOK.

Available off the shelf from Arrow Electronics, Hall-Mark and Hamilton/Avnet.

Remember, you always get FULL SPEC PERFORMANCE from TRW LSI.

To receive a data sheet without delay, or for super-fast information, call or write our Literature Service Department:

LSI Products Division,
TRW Electronic Components Group,
P.O. Box 2472, La Jolla, CA 92038,
619.457.1000

In Europe, call or write:
TRW LSI Products,
Konrad-Celtis-Strasse 81,
8000 Muenchen 70, W. Germany,
089.7103.115

In the Orient, phone:
Hong Kong, 3.856199;
Tokyo, 03.461.5121; Taipei, 751.2062

*U.S. price in 1000s — $15.00 Commercial CERDIP.
†0 °C to 70 °C (−55 °C to 125 °C also available)
©TRW Inc. 1985 — TRS-5109

TRW

LSI Products Division
TRW Electronic Components Group

NEWS BREAKS: INTERNATIONAL

CPU CARD, SOFTWARE INTEGRATE REAL-TIME PROCESSING AND UNIX

Featuring a 68010 μP, math coprocessor, memory-management unit, SCSI bus interface, four RS-232C serial ports, and 2M or 4M bytes of RAM, the TSVME106 VME Bus CPU card from Thomson Semiconducteurs (Velizy, France, TLX 204780) provides a complete operating environment for Unix System V. Because Unix tasks don't need to access memory via the VME Bus, the bus is free for other CPUs to run real-time application programs. To link real-time programs running under pSOS-68K into Unix supervisory programs, the company's TSVME791 software, priced at Fr fr 12,000, provides a Unix-to-pSOS link. Communicating via shared memory on the VME Bus, this link allows you to route the output of Unix tasks to the input of pSOS tasks and vice versa. Depending on memory prices during the second quarter, the TSVME106 will cost approximately Fr fr 35,000.—Peter Harold

SILICON COMPILER USES TI/PHILIPS/ES2 AND MIETEC CELL LIBRARIES

Running on VAX-VMS computers, the ASA silicon compiler from Sagantec bv (Eindhoven, The Netherlands, TLX 59163) allows you to minimize the chip area required to implement digital ASIC designs. The compiler's front-end processing includes schematic capture and high-level simulation software; the layout generator handles standard-cell libraries from Texas Instruments, Philips, ES2, and Mietec. Databases of foundry-dependent parameters allow you to design to the requirements of Texas Instruments' and Mietec's bulk CMOS processes. The software license for the compiler costs $50,000 and $80,000. A version running under Unix is under development.—Peter Harold

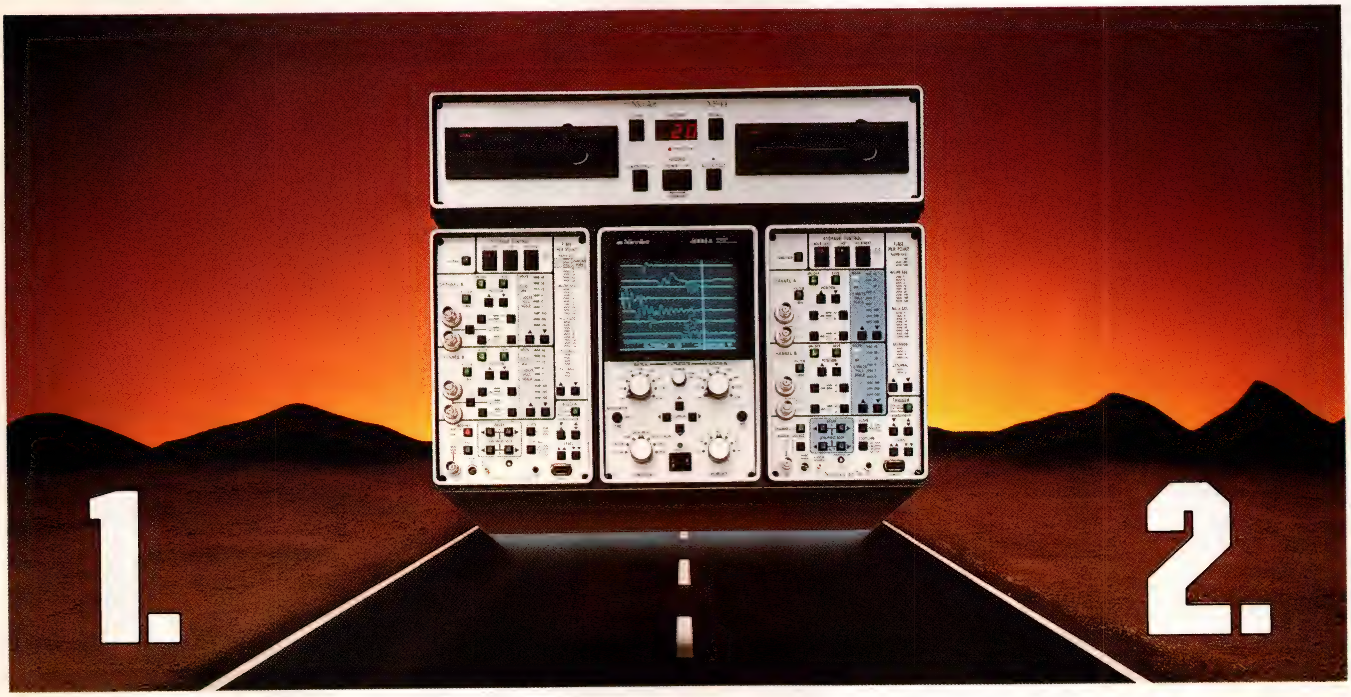
LOW-COST WORKSTATION OFFERS 2.5- TO 4-MIPS PROCESSING POWER

Housed in a PC-style desktop package, the Vitesse graphics workstation from Cambridge Micro Computers Ltd (Cambridge, UK, TLX 817923) provides vector-drawing and area-fill speeds on its 1024×768-pixel resolution color monitor as high as 2.5 and 1 μsec/pixel, respectively. The workstation displays as many as 16 colors from a palette of 4096 colors. The hardware is based around a VME Bus system and runs a 16-, 20-, or 25-MHz 68020 μP and 68881 math coprocessor. It incorporates floppy- and Winchester-disk drives and includes five RS-232C interfaces and an Ethernet interface. The workstation, which starts at £9950, is supplied with a single-user Unix license. Two- and 3-dimensional graphics software packages are also available.—Peter Harold

IMAGE-ANALYSIS SYSTEM IS BASED ON IBM PC

The μMagiscan image-analysis system from Joyce-Loebl (Gateshead, UK, TLX 53257; in the US, (516) 222-0941) is built around an IBM PC with a color-graphics adapter board, a 10M-byte hard-disk drive, an Intel 8087 math coprocessor, a TI 320 coprocessor, and a video I/O pc-board frame grabber to provide 256×256×8-bit images. In addition to the IBM PC monitor, the system also has a separate color monitor for displaying the image-analysis operations. The custom-designed software is divided into three programs: Test, which gives you a quick method to check the system; Menu, which lets you perform all the basic image-analysis routines; and Results, which provides a rapid overview of the measurements. The system costs $25,000.—Joan Morrow

THE FIRST NAME IN DIGITAL SCOPES



TWO DIGITAL SCOPES IN ONE.

The Acquisition.

With sweep speeds from days to nanoseconds and resolution up to 15 bits, the 4094 digital 'scope can capture the most elusive signals. Every plug-in has 16K of memory, viewable trigger set-up and independent pre- or post-trigger delay on each channel. Signal averaging is standard and our latest 10 MHz/12-bit plug-in even offers real time manipulation of the incoming signals. With two plug-ins the 4094 can record four channels simultaneously. Or even monitor two slow signals and capture high speed glitches at the same time. All under computer control or via manual operation: whatever your application demands.

The Analysis.

Expand and examine any waveform feature in detail. Use the dual cursors and numerics to measure the time or voltage of any point. Compare live or stored waveforms with each other or with pre-recorded references. Store signals on disk manually or automatically. Use pushbutton programs to manipulate the data or send it to your computer via GPIB or RS232 interface. Complete your report with a hardcopy plot using the XY/YT recorder or digital plotter outputs.

First Time, Everytime.

Don't miss important data because of set-up errors. From the World's first in 1973 to the latest models, Nicolet 'scopes are easy to use. Find out how they can be the quickest solution to your signal problems. For more information call 608/273-5008, or write Nicolet Test Instruments Division, P.O. Box 4288, 5225 Verona Road, Madison, WI 53711-0288.

Nicolet

For more information circle 4

tough attenuators

from $11.95 (1-49)

one-piece design defies rough handling

Check these features:

✓ Each unit undergoes high-impact shock test
✓ Available from 1 to 40 dB
✓ DC to 1500 MHz
✓ Unexcelled temperature stability, .002 dB/°C
✓ 2W max. input power (SMA is 0.5W)
✓ BNC, SMA, N and TNC models
✓ Immediate delivery, 1-yr. guarantee

NEW!

Precision 50-ohm terminations... only $6.95 (1-24)
DC to 2 GHz, 0.25W power rating, VSWR less than 1.1
BNC (model BTRM-50), TNC (model TTRM-50)
SMA (model STRM-50), N (model NTRM-50)

*Freq. (MHz)	Atten. Tol. (Typ.)	Atten. Change, (Typ.) over Freq. Range		VSWR (Max.)	
		DC–1000	1000–1500	DC–1000 MHz	1000–1500 MHz
DC-1500 MHz	±0.3	0.6	0.8	1.3	1.5

*DC–1000 MHz (all 75 ohm or 30 dB models) DC-500 MHz (all 40 dB models)

MODEL AVAILABILITY
Model no. = a series suffix and dash number of attenuation.
Example: CAT-3 is CAT series, 3 dB attenuation.
■ denotes 75 ohms; add −75 to model no.
● denotes 50 ohms

ATTEN	SAT (SMA)	CAT (BNC)	NAT (N)	TAT (TNC)
1	●	●	●	●
2	●	●	●	●
3	●	●■	●	●
4	●	●	●	●
5	●	●	●	●
6	●	●■	●	●
7	●	●	●	●
8	●	●	●	●
9	●	●	●	●
10	●	●■	●	●
12	●	●	●	●
15	●	●■	●	●
20	●	●■	●	●
30	●	●	●	●
40	●	●	●	●

PRICING (1-49 qty.): CAT (BNC)..$11.95, SAT (SMA)..$14.95
TAT (TNC)..$12.95, NAT (N)..$15.95

finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

C 92 REV. B

CIRCLE NO 161

value-packed
filters from $9.95

dc to 3GHz

- less than 1dB insertion loss over entire passband
- greater than 40dB stopband rejection
- 5 section, 30dB per octave roll-off
- VSWR less than 1.7 (typ)
- over 100 models, immediate delivery
- meets MIL-STD-202
- rugged hermetically sealed package (0.4 x 0.8 x 0.4 in.)
- BNC, Type N, SMA available

finding new ways ...
setting higher standards

Mini-Circuits
A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

LOW PASS	Model *LP–	10.7	50	70	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to		10.7	48	60	98	140	190	270	400	520	580	700	780	900
Max. 20dB Stop Frequency (MHz)		19	70	90	147	210	290	410	580	750	840	1000	1100	1340

Prices (ea.): P $9.95 (6-49), B $24.95 (1-49), N $27.95 (1-49), S $26.95 (1-49)

HIGH PASS	Model *HP–	50	100	150	200	300	400	500	600	700	800	900	1000
Pass Band (MHz)	start, max.	41	90	133	185	290	395	500	600	700	780	910	1000
	end, min.	200	400	600	800	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)		26	55	95	116	190	290	365	460	520	570	660	720

Prices (ea.): P $12.95 (6-49), B $27.95 (1-49), N $30.95 (1-49), S $29.95 (1-49)

*Prefix P for pins, B for BNC, N for Type N, S for SMA *example:* **PLP-10.7**

CIRCLE NO 160

C105 REV. B

AT&T Single Chip DSPs:
the first and the fastest.

Now AT&T offers the world's first floating point and fastest fixed point DSPs.

Only AT&T can give you a complete single-chip Digital Signal Processor solution for all your analog and digital applications. Because, only AT&T has a single-chip floating point DSP in full production, as well as the fastest fixed point DSP available.

Speed and flexibility.
The AT&T DSP32 has a 32-bit floating format with 24 bits of precision. It has an on-chip CAU that allows it to perform like a 16-bit microprocessor with 32-bit floating point capabilities. This makes precision possible over a wider range, so essential for high tech applications such as computer aided design, image processing and speech compression.

If your requirement is for faster speeds, our fixed point DSP16 operates at 75 ns. It is the first single-chip DSP to approach "building block" speeds.

Easier programming, development and debugging.
AT&T's DSPs make it easier to develop algorithm implementations. Unlike competitive DSPs, AT&T DSPs are programmed using high level C-like Syntax, which is equation-like and much easier to program. AT&T also offers a complete single-board system for the development and real-time evaluation of your DSP programs. Plus, we offer a complete UNIX® and MS*-DOS software library for creating, testing and debugging applications programs.

Single chip means savings.
So, whatever your applications: voice signal filtering, speech and video signal compression, spectral analysis, graphics and computer-aided design, AT&T's single-chip DSPs can cut your development time as well as cutting power consumption and board area.

And, of course, AT&T Bell Laboratories' ongoing R&D will assure you that AT&T will stay at the forefront of DSP technology.

For more information, call **1 800 372-2447**, or send the reply coupon. In Europe, call AT&T Microelectronics in Munich, Germany at 089/95970, Telex 5216884. In Singapore, call 2508422/2533722, Telex RS21473/RS55038. Let us show you why AT&T is the only DSP supplier with a complete single-chip solution for all your analog and digital applications.

*Trademark of the Microsoft Corporation

AT&T Dept. 203130, 555 Union Blvd., Allentown, PA 18103 EDN031887
Please send me more information about AT&T's DSPs.

Name ______________________________

Title ______________________________

Company ______________________________

Address ______________________________

City ______________________________

State ______________ Zip ______________

Telephone (   ) ______________________________

© 1987 AT&T

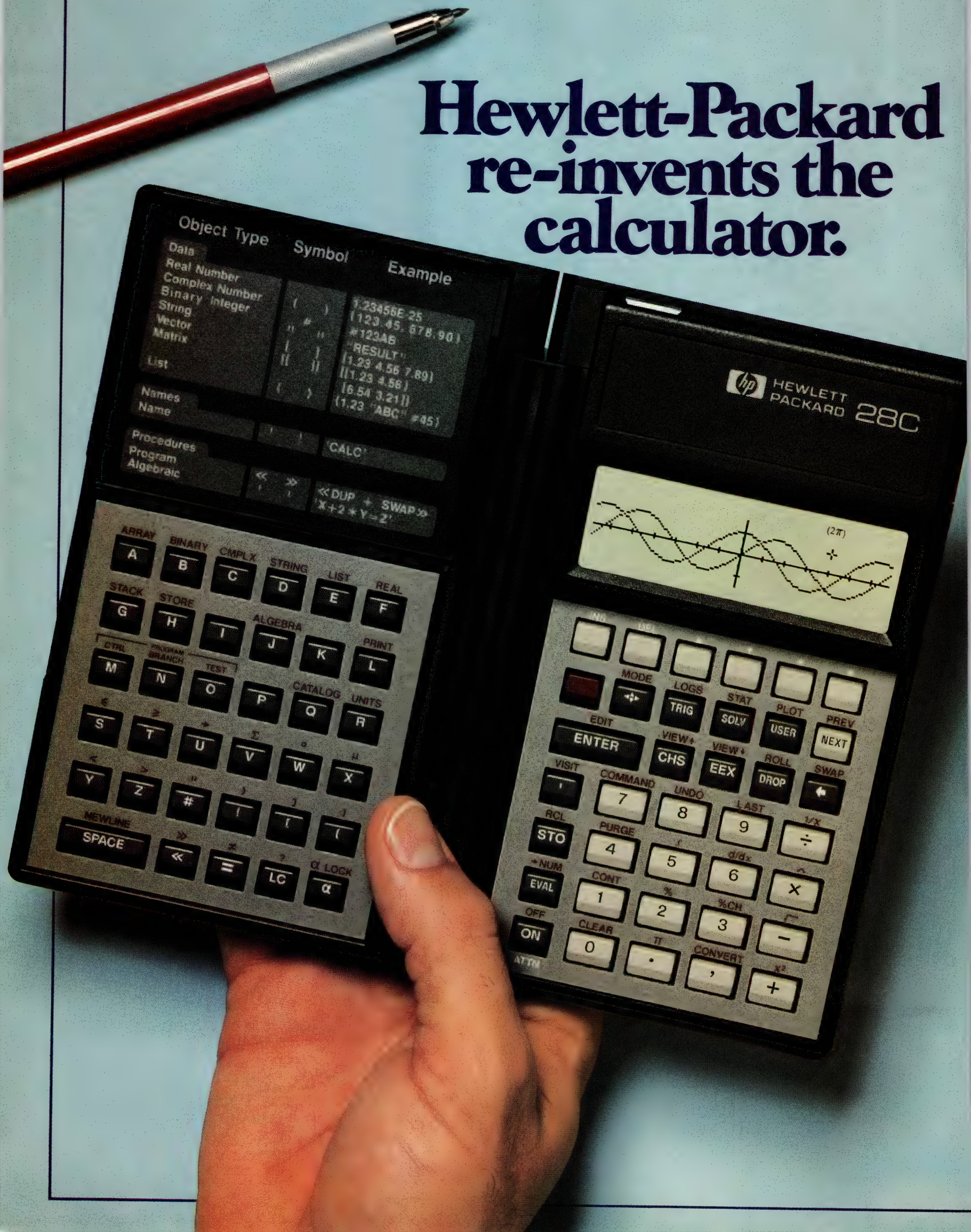
AT&T

The right choice.

See us in New York City at Electro-Mini/Micro, Booth 2920.

CIRCLE NO 173

Hewlett-Packard re-invents the calculator.



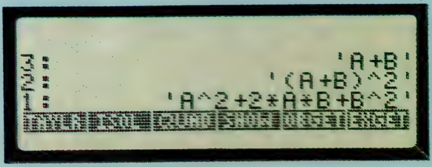
ENGINEERING RESPONSIBILITY ☒ SEPIA ☒

D-00028-40001-1

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED	DRE	9/8/86

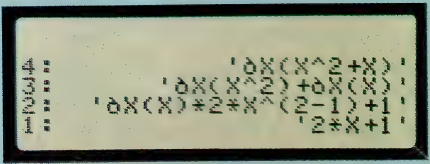
THE NEW HP-28C DOES THINGS NO OTHER CALCULATOR CAN. AND IT DOES MORE THINGS THAN ANY OTHER CALCULATOR CAN. MORE THAN THE UNIQUE FUNCTIONS DISPLAYED ON THE LEFT, THE HP-28C ALSO BRINGS TOGETHER SUCH FEATURES AS KEYSTROKE PROGRAMMABILITY; RPN LOGIC WITH ALGEBRAIC EXPRESSION ENTRY; 120 UNIT CONVERSION FACTORS; HEX, OCTAL AND BINARY MATH--AND CONVERSIONS; ADVANCED STATISTICS; AND THE ABILITY TO USE AN OPTIONAL PRINTER VIA INFRARED BEAM. FOR A DEMONSTRATION,

THE FIRST CALCULATOR THAT DOES SYMBOLIC ALGEBRA



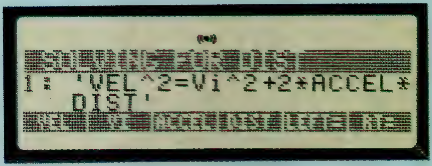
```
3:                    'A+B'
2:                '(A+B)^2'
1:      'A^2+2*A*B+B^2'
TAYLR ISOL QUAD SHOW OBGET EXGET
```

THE FIRST CALCULATOR THAT DOES SYMBOLIC CALCULUS



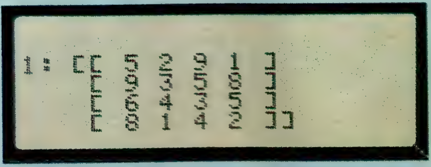
```
4:              '∂X(X^2+X)'
3:        '∂X(X^2)+∂X(X)'
2:  '∂X(X)*2*X^(2-1)+1'
1:                  '2*X+1'
```

THE FIRST SCIENTIFIC CALCULATOR THAT ACCEPTS YOUR OWN FORMULAS, THEN SOLVES FOR ANY UNKNOWN



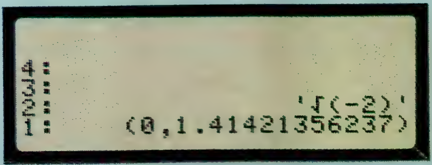
```
SOLVING FOR DIST
1: 'VEL^2=Vi^2+2*ACCEL*
   DIST'
VEL   Vi   ACCEL DIST LEFT= RT=
```

THE FIRST CALCULATOR THAT PERFORMS MATRIX OPERATIONS AS EASILY AS FOUR-FUNCTION MATH



```
1: [[ 5  2  9  1 ]
    [ 9  3  5  8 ]
    [ 6  4  5  6 ]
    [ 8  1  4  2 ]]
```

THE FIRST CALCULATOR THAT DOES COMPLEX NUMBER ARITHMETIC AS EASILY AS FOUR-FUNCTION MATH



```
4:
3:
2:                  '√(-2)'
1:    (0,1.41421356237)
```

CALL 1-800-367-4772, EXT. 215 G AND ASK FOR THE NAME OF YOUR NEAREST HP DEALER. THEN SEE QUOD ERAT DEMONSTRANDUM.

Q.E.D.

HEWLETT PACKARD

DO NOT SCALE THIS DRAWING			© 1987 Hewlett-Packard Company	PG12611		SEE NOTE
	ITEM	QTY.	PART/MATERIAL-DESCRIPTION	MAT'L-PART NO.	MAT'L-DWG. NO.	MAT'L-SPEC.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

TOLERANCES .XX±.02 .XXX±.005

SEE CORP. STD. 608

DRAWN BY JERRY STEIGER	DATE 4/20/86	TITLE TOPCASE-NUMERIC	PART NUMBER 00028-40001
ENGINEER/CHECKER JERRY STEIGER	4/20/86		
RELEASE TO PROD.			
SUPERSEDES DWG.		SCALE 2X	SHEET 1 OF 1

D-00028-40001-1

SIGNALS & NOISE

Career speakers ignore engineering's drawbacks

Dear Editor:

In your editorial "Youngsters deserve a look at engineering" (EDN, December 11, 1986, pg 51), you suggest that it is time to inform young people about careers in engineering so that they can be persuaded to enter the field. You suggest the time-honored approaches, whereby gullible high-school students are exposed to industry trade shows and to speakers from various local companies that employ engineers.

Without a doubt, the speakers supplied to the schools' Career Days are those that espouse the management viewpoint of the companies that furnish them. No mention will be made of the massive, ongoing layoffs. Nobody will point out that, according to the College Placement Council, the EEs in the class of 1986 received 36.5% *fewer* job offers than did those in the class of 1985. Nobody will breathe a word of the fact that this nation is in the midst of a worsening high-tech depression. Nobody will bring up the uncomfortable fact that an employed engineer's inventions belong to the employer and not to the engineer. Nobody will speak of the fact that the professional engineering societies represent the professors and the corporate executives and not the working engineers.

The problem with your suggestion is that our young people receive the impression that engineering is a fulfilling career and not a dead-end one, that engineering is a stable career and not an uncertain one, and that engineering demands a high level of technical skill on the part of the practitioner and not a large amount of clerical skill.

By all means, let us give our youngsters a look at engineering careers, but let's make certain that this look is an accurate one.

Incidentally, Mrs Feerst and I are both degreed engineers who have persuaded our two sons, under penalty of shattered kneecaps, to enter other careers.

Sincerely yours,
Irwin Feerst
Committee of Concerned EEs
Massapequa Park, NY

Engineers are considered a consumable resource

Dear Editor:

The December 11, 1986, issue of EDN presents an interesting dichotomy. On page 51, you extol the virtues and rewards of an engineering career, while on page 306 (in the Professional Issues section) we read how the father of the CEO of a small company in the South Bronx "was one of the thousands of engineers

Text continued on pg 34

QWIK TEK™ The Complete CAE Solution
Schematic Capture • Auto Placement • Auto Router

Big CAD Layout...
Small $$$$ Outlay

Compare Qwik Tek™ quality and cost performance to P-CAD,™ Racal-Redac, FutureNet...

- Schematic Capture
- PC Board Layout
- Easy Tutorial Learning
- 50 Layer Graphics Editor
- Surface Mount, Analog, Digital, and ECL Design
- IBM® PC/XT/AT or compatibles and DEC® VAX™/MicroVAX™

Trademarks: Qwik Tek-QTECH, Inc.; AT-International Business Machine Corp., VAX, MicroVAX-Digital Equipment Corp., P-CAD-P-CAD. Registered Trademarks: IBM-International Business Machine Corp., DEC-Digital Equipment Corp.

QTECH
256 E. Hamilton, Suite L • Campbell, CA 95008
|800| 538-8157—Ext. 845 • In CA |800| 672-3470—Ext. 845

CIRCLE NO 12

THICK-FILM NETWORKS...FAST.

4SR-5125 R2

SPRAGUE NETWORKS FOR TOP QUALITY, QUICK DELIVERY.

When it comes to thick-film resistor, capacitor and r-c networks, Sprague means top quality and fast delivery. Anytime. Anywhere. Our precision networks are available in SIPs, DIPs and surface-mount packages. We supply industry-standard parts and custom designs…at competitive prices. Our new catalog covers brand new products: Type 201C Capacitor Networks, Type 206C R-C Networks, Series 800 Surface-Mount Networks, and molded-case SIP Mil Resistor Networks. For pricing or applications assistance, call our Customer Service Hotline at 603/883-9774. For our new Thick-Film Products Catalog, RN-126, write to: Technical Literature Service, Sprague Electric Company, 41 Hampden Rd., P.O. Box 9102, Mansfield, MA 02048-9102.

Sprague Electric Company, a Penn Central unit. Thick-Film Products Division, Nashua, NH. World Headquarters, Lexington, MA.

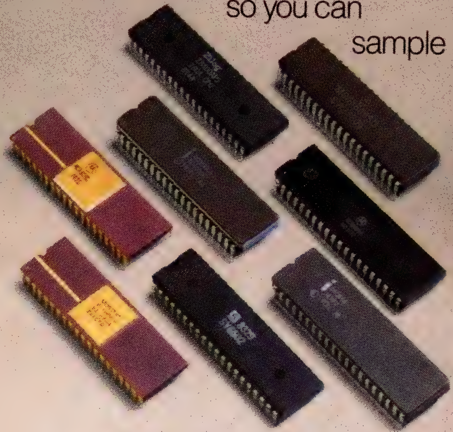
SPRAGUE
THE MARK OF RELIABILITY

CIRCLE NO 159

TEK'S NEW EASY-TO-EXPERT LOGIC ANALYZER $3995.*

Introducing the Tek 1220 and 1225: the two newest members of the Tek 1200 Series of logic analyzers. Nothing else in their price range delivers so much and makes it all so easy to use. Consider:

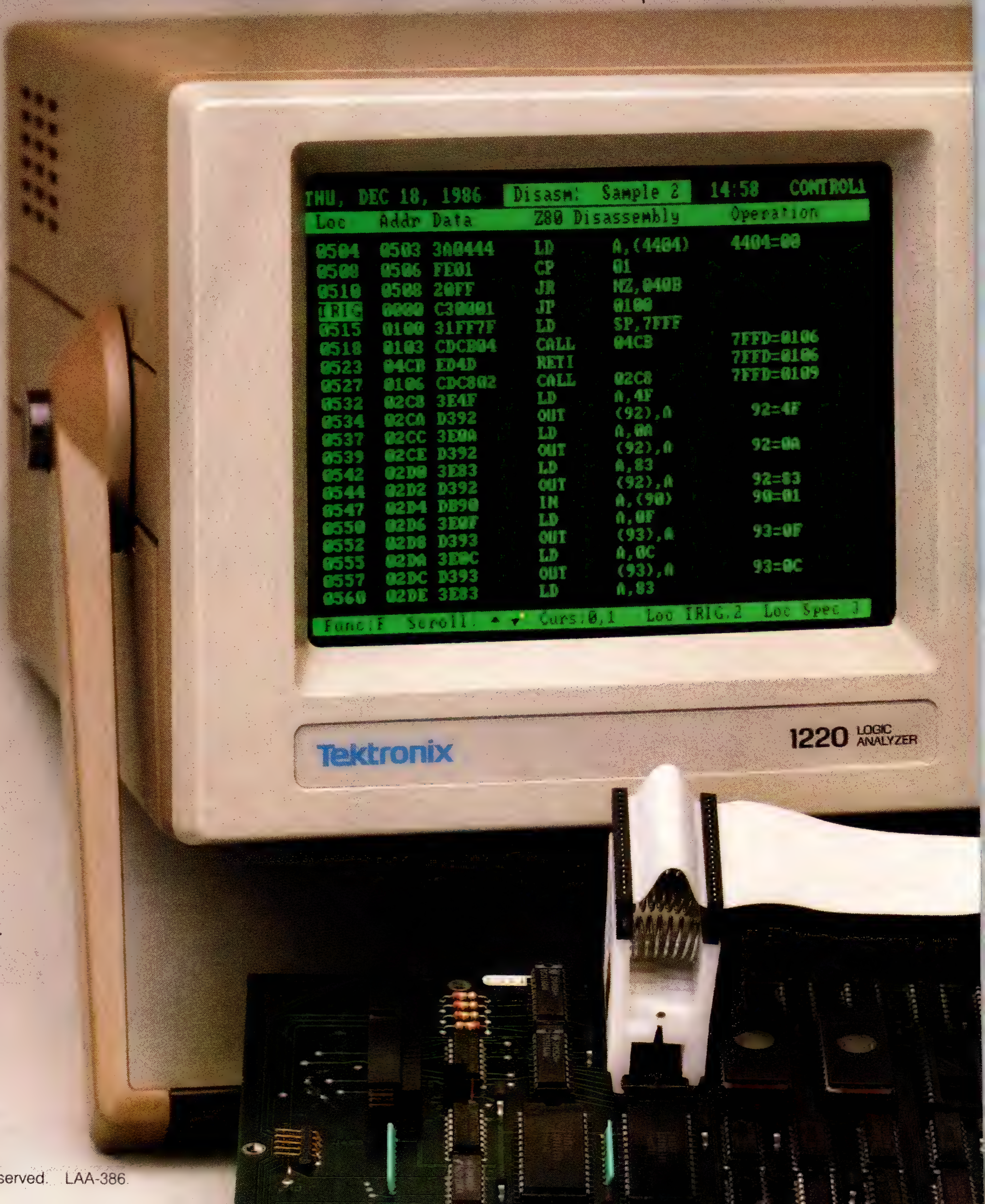
1 Powerful state, timing and disassembly analysis. The 1220 and 1225 provide 32 or 48 data channels, respectively, in groups of 16-channels, with channel groups clocked independently or linked together — so you can sample data from as many as three circuit sections at once.



Tek currently provides support for the most popular microprocessors, with additional 8- and 16-bit personality modules to be introduced continually.

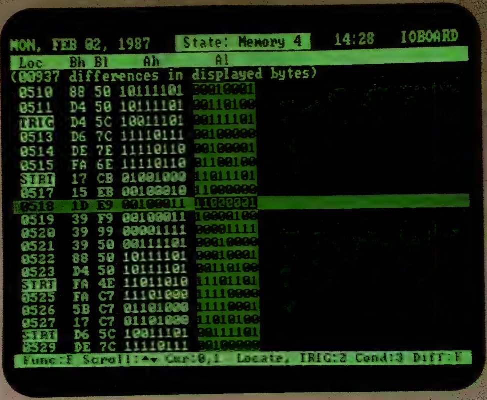
2 A total of four 2K nonvolatile memories support each channel. Acquire data in one memory and compare it to data in any of the three other memories.

Clock/calendar plus storage for up to eight test setups are also in battery-backed memory. Date and time of storage are included with each data memory, so it's easy to find and interpret results.

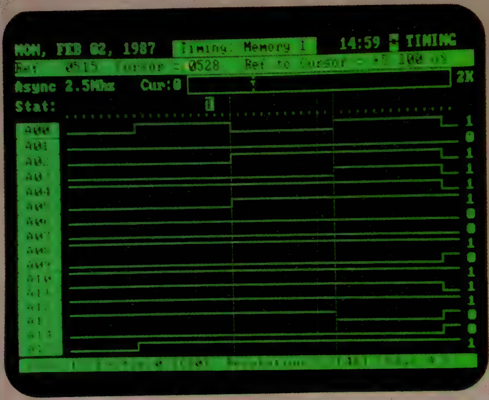


```
THU, DEC 18, 1986   Disasm: Sample 2   14:58   CONTROL1
Loc   Addr Data        Z80 Disassembly         Operation
0504  0503 3A0444     LD     A,(4404)        4404=00
0508  0506 FE01       CP     01
0510  0508 20FF       JR     NZ,040B
TRIG  0000 C30001     JP     0100
0515  0100 31FF7F     LD     SP,7FFF
0518  0103 CDCB04     CALL   04CB            7FFD=0106
0523  04CB ED4D       RETI                   7FFD=0106
0527  0106 CDC802     CALL   02C8            7FFD=0109
0532  02C8 3E4F       LD     A,4F
0534  02CA D392       OUT    (92),A            92=4F
0537  02CC 3E0A       LD     A,0A
0539  02CE D392       OUT    (92),A            92=0A
0542  02D0 3E83       LD     A,83
0544  02D2 D392       OUT    (92),A            92=83
0547  02D4 DB90       IN     A,(90)            90=01
0550  02D6 3E0F       LD     A,0F
0552  02D8 D393       OUT    (93),A            93=0F
0555  02DA 3E0C       LD     A,0C
0557  02DC D393       OUT    (93),A            93=0C
0560  02DE 3E83       LD     A,83
Func:F  Scroll: ▲ ▼  Curs:0,1   Loc TRIG.2   Loc Spec 3
```

*U.S. domestic price only. Copyright ©1987, Tektronix, Inc. All rights reserved. LAA-386.



```
MON, FEB 02, 1987   State: Memory 4    14:28   IOBOARD
 Loc    Bh Bl     Ah          Al
(00937 differences in displayed bytes)
 0510   88 50 10111101 00010001
 0511   D4 50 10111101 00110100
 TRIG   D4 5C 10011101 00111101
 0513   D6 7C 11110111 00100000
 0514   DE 7E 11110110 00100001
 0515   FA 6E 11110110 01100100
 STRT   17 CB 01001000 11011101
 0517   15 EB 00100010 11000000
 0518   1D E9 00100011 11000001
 0519   39 F9 00100011 10000100
 0520   39 99 00001111 00001111
 0521   39 50 00111101 00010000
 0522   88 50 10111101 00010001
 0523   D4 50 10111101 00110100
 STRT   FA 4E 11011010 11101101
 0525   FA C7 11101000 11110000
 0526   5B C7 01101000 11110001
 0527   17 C7 01101000 11010100
 STRT   D6 5C 10011101 00111101
 0529   DE 7C 11110111 00100000
 Func:F Scroll:▲▼ Cur:0,1  Locate, TRIG:2 Cond:3 Diff:F
```



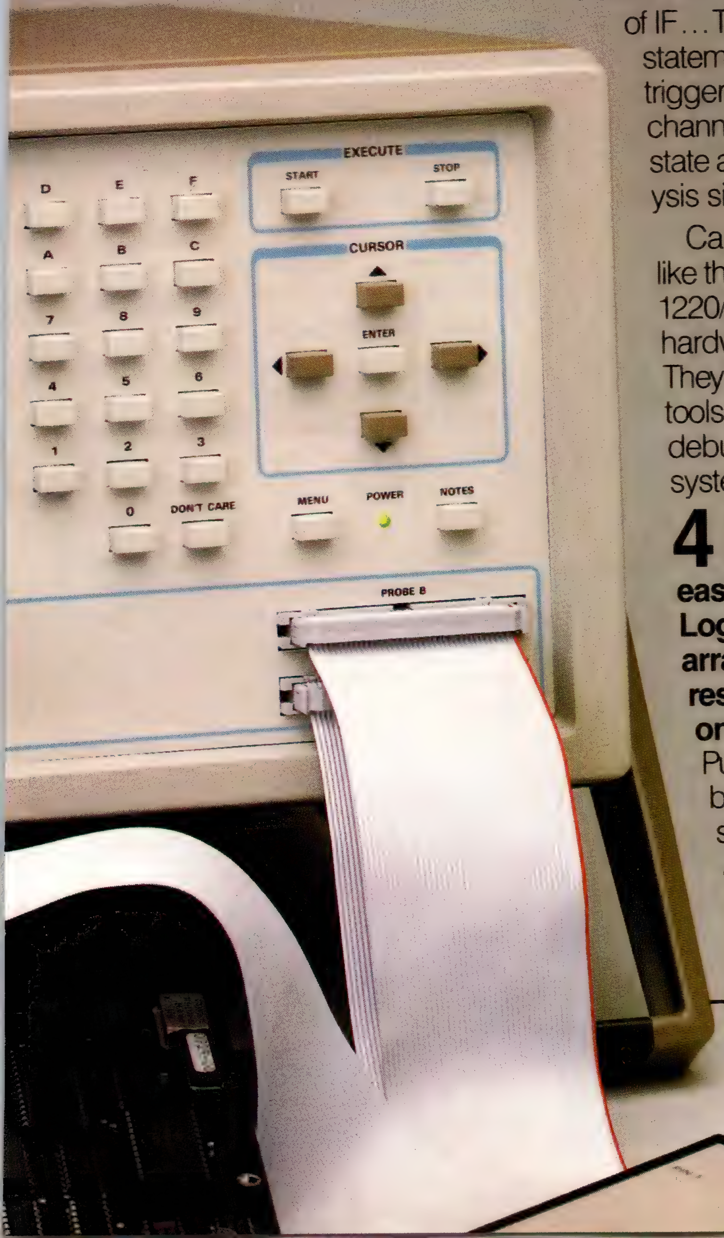
```
MON, FEB 02, 1987   Timing: Memory 1    14:59   TIMING
       0515   Cursor = 0528   Ref to Cursor
Async 2.5Mhz    Cur:0                            2K
Stat:
```

Left Set reference cursors on the timing diagram to measure pulse width or the time between pulse edges. **Above** State tables are displayable in binary or hex formats.

3 Triggering can be as simple or sophisticated as you choose.

Specify up to 24 trigger conditions. Conditionally branch with up to 12 levels of IF...THEN...ELSE statements. Cross-trigger between channel groups. Do state and timing analysis simultaneously.

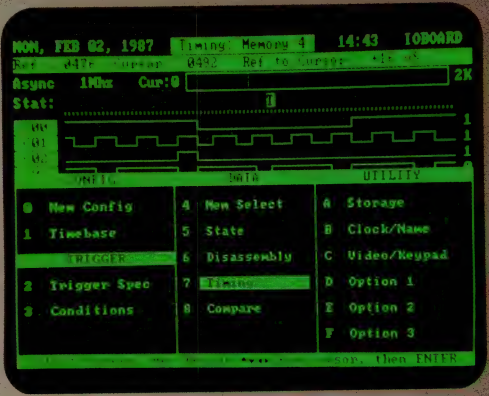
Capabilities like these make the 1220/1225 more than hardware analyzers. They are capable tools for both software debugging and system integration.



4 Pop-up menus are easy to use. Logically arranged. And respond instantly on command.

Push one button for on-screen notes appropriate to the current display.

Use the optional interfaces to control the instruments via computer and attach inexpensive dot matrix printers for immediate documentation.



```
MON, FEB 02, 1987   Timing: Memory 4    14:43   IOBOARD
          0492   Ref to Cursor
Async   1Mhz    Cur:0                            2K
Stat:
                          DATA               UTILITY
 0  New Config      4  Mem Select      A  Storage
 1  Timebase        5  State           B  Clock/Name
      TRIGGER       6  Disassembly     C  Video/Keypad
 2  Trigger Spec    7  Timing          D  Option 1
 3  Conditions      8  Compare         E  Option 2
                                       F  Option 3
                                          sor, then ENTER
```

Above Pop-up menus, such as this main menu, are easy to understand and logically arranged.

5 This is affordable logic analysis in a league by itself.

Users can evolve from one unit to another, through the entire 1200 Series, with a minimum of readjustment. You can be confident that Tek quality is built in, and that documentation and service will be there when required.

Call 1-800-245-2036 (in Oregon, 231-1220) for more information or for the name of your nearest Tek sales engineer. Learn why these are the first low-cost logic analyzers that don't act like it.

Tektronix®
COMMITTED TO EXCELLENCE

Circle 7 for literature

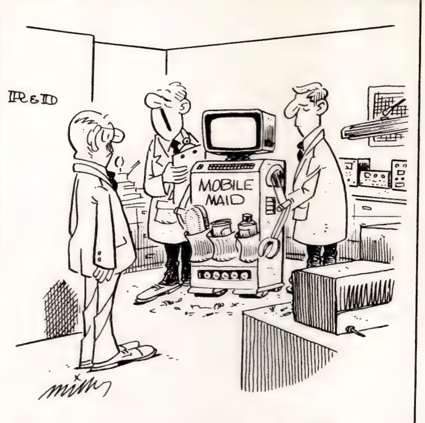
Circle 46 for sales contact

who lost their jobs during the 1960s."

During my 30 years as an engineer, I have seen layoffs, threats of layoffs, salaries that have lagged well behind the cost-of-living index, uncompensated overtime, and the feeling that engineers are considered by the management of most companies to be a consumable resource.

If high-school students were truly given the "realistic exposure to engineering and its rewards" that you call for in your editorial, far fewer high-school students would go on to pursue careers in engineering.

Sincerely yours,
Allan Koszyn
Yonkers, NY



"WE'VE TRIED, BUT IT STILL WON'T DO WINDOWS."

Few engineers reap the career's rewards

Dear Editor:

Yes, it is time to tell more young people about engineering careers. By failing to teach more students about engineering, we might lure more innocent minds into the career of engineering, whose college curriculum is one of the toughest and whose rewards are among the highest.

A small fraction of engineering students make it up through the ranks, some because they are exceptional, some because they know someone. The majority do not make it and are forever being pushed around (if they're lucky). Most of us are simply discarded.

We in our 50s buy our own computers, study to keep abreast, and develop much of our work at home. So what kind of reward do we get? Some young engineer becomes our supervisor; he or she decides we are surplus, and we land in the street.

Thousands of engineers are in that position. Because the Social Security retirement program is slowly going bankrupt, it's inevitable that the retirement age will be increased to 70. What is going to happen to the discarded engineer over 50? Will he or she have to tolerate this degrading treatment that much longer?

My advice to young people is this: Yes, engineering education is superior to most other kinds. If you must

Text continued on pg 38

MORE FOR LE$$

The New HX Series
250 Watt-350 Watt

Multiple and
Single Output
OEM Switching
Power Supplies

HX250 1,000 piece price $175.00 • HX350 1,000 piece price $245.00

HX SERIES MULTIPLE OUTPUTS

Models	+5V	−5V	+12V	−12V	+15V	−15V	+24V	+12V	Total Power	Dimensions L W H
HX250-3100	40A		10A	3A					250 Watts	10.5″ × 5″ × 2.5″
HX250-3200	40A				3A	3A				
HX250-4103	40A	3A	10A	3A						
HX250-4104	40A		3A	3A			5A			
HX250-4105	40A		10A	3A				3A		
HX250-4204	40A				3A	3A	5A			
HX350-3100	65A		10A	5A					350 Watts	11.5″ × 5″ × 2.5″
HX350-3200	65A				5A	5A				
HX350-4103	65A	5A	10A	5A						
HX350-4104	65A		5A	5A			5A			
HX350-4105	65A		10A	5A				5A		
HX350-4204	65A				5A	5A	5A			

Single outputs available in 5V, 12V, 15V, 24V and 48V.

- Primary output adjustable +20% to −5%.
- Auxiliary outputs adjustable ±5%.
- All outputs isolated.
- Remote inhibit.
- Current mode control.
- Power fail detect, TTL signal high or low optional.
- Outputs tailored to your specifications.
- Remote sense.
- Extruded aluminum chassis.

SE Summit® Electronics
A Division of Basler Electric, Highland, Illinois

855 East Collins Blvd.
Richardson, TX 75081
(214) 231-1456 • FAX (214) 680-2457
Toll Free (800) 645-2074

CIRCLE NO 13

YOU'VE READ A LOT LATELY ABOUT DSP.

NOW HERE'S THE LAST WORD.

With all the talk about digital signal processing these days, it's hard to know what to believe. At Zoran, we'd like to make it easy for you.

For us, DSP isn't just a sideline, as it is at other companies. It's the bottom line. Because it's all we do.

Which means we strive to achieve only one objective. Developing the high-performance DSP products you need for faster, easier system design.

As evidenced by the Zoran Vector Signal Processor (VSP)™ and Digital Filter Processor (DFP).

Two new signal processors that enable you to do something you've never done before. Like design your system from the top down.

With a systems perspective in mind, which enables you to focus on your application, instead of on your implementation.

Using single, highly integrated system-processor devices that use parallel processing to deliver all the speed of building blocks. Without all the hassles of discrete components and extensive programming.

What's more, you'll design your system in a lot less time. At a lower cost. And with greater ease and flexibility than you ever thought possible.

Best of all, we're shipping products now. Instead of simply announcing them. Which means you don't have to wait to get the jump on your competition.

High performance never looked so easy. We didn't think it was enough for the VSP and the DFP to be the fastest DSP devices. So we also made them the easiest to use.

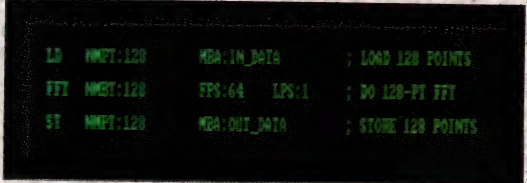
We developed proprietary architectures and optimized them for faster, more efficient execution of embedded DSP algorithms, such as FFTs and FIRs.

And we slashed programming time with a high-level instruction set that shrinks hundreds of lines of code to a mere handful, speeding system design.

On top of that, we developed a modular design that lets you configure multiple VSPs and DFPs in parallel to achieve even higher performance.

And we utilized proven double-layer metal CMOS technology for lower power consumption and higher reliability.

VSP: Powerful vector processing capability. Until now, you needed the power of an array processor if you wanted to do vector processing. But that was before Zoran developed the Vector Signal Processor.



```
LD   NMPT:128    MBA:IN_DATA         ; LOAD 128 POINTS
FFT  NMPT:128    FPS:64    LPS:1     ; DO 128-PT FFT
ST   NMPT:128    MBA:OUT_DATA        ; STORE 128 POINTS
```

Three simple VSP instructions execute a 128-point complex FFT in 237 microseconds.

© Copyright 1987 Zoran Corporation
VAX is a trademark of Digital Equipment Corporation
VSP is a trademark of Zoran Corporation

The world's most powerful DSP processor. And the first to process data in blocks, or vectors, instead of processing only one input at a time, as is the case with scalar processors.

Which means you can easily achieve bit-slice performance with a single component. And you can do it in a lot less time.

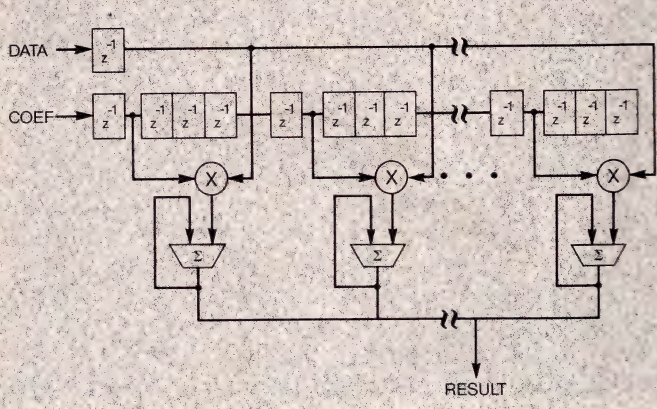
Because our embedded high-level instruction set eliminates the need to write lines and lines of code.

So you can concentrate on your end application, instead of getting bogged down in the details of software implementation.

And with our unique VSP architecture, multiple tasks, such as managing the bus interface and executing algorithms, are handled concurrently for even faster operation.

A 1024-point complex FFT, for example, takes just 2.6 ms with the VSP. Using only a kernel of three simple instructions.

The VSP also provides better dynamic range, thanks to the use of 16-bit block floating point arithmetic. Which retains the precision of the original signal during FFT operations.



DFP architecture utilizes parallel processing to deliver 320 million operations per second.

DFP: Faster FIR filtering with parallel processing. Designed for extremely high-speed FIR filtering and 2D real-time convolutions, the DFP family delivers the high performance of building blocks. But with the high integration of a single device.

Each DFP consists of four or eight filter cells configured as a unique parallel-processing system. Each cell contains an 8 x 8 or 9 x 9 bit multiplier, a 26-bit accumulator and three decimation registers.

And with each cell computing 20 million additions and 20 million multiplications per second, the DFP is capable of performing 320 million operations per second. At a blazing 20MHz throughput. So you can easily convolve images in real time.

Moreover, you can cascade multiple DFPs for higher-order filters, or implement them in parallel for even greater precision.

All the tools and support you'll ever need. Most DSP support doesn't give you much to lean on. So we decided to provide you with all the help you need to shorten your development cycle and get to market faster, ahead of the competition.

Like VAX™ and PC-based hardware and software tools that let you simulate a complete DSP application. In-depth training classes and seminars. And comprehensive application notes and application assistance from experts in DSP system design.

All of which explains why the Digital Filter Processor and Vector Signal Processor are currently in use in such computation-intensive applications as image processing, instrumentation and high-speed communications.

Comprehensive hardware and software development tools shorten your time to market.

Get the word on Zoran. For a *free* Zoran databook, call 1-800-441-2345, ext. 99 (in CA) or 1-800-556-1234, ext. 99 (outside CA).

Or write Zoran Corporation, Dept. MC, 3450 Central Expressway, Santa Clara, CA 95051. We'll get the word out to you.

THE LAST WORD IN DSP. ZORAN

be an engineer, get at least three promotions in the first 10 years. If you don't, get out and use your superior training in another field; otherwise, you'll be in hell the rest of your life. The younger you are when you get your degree, be it bachelor's, master's, or doctorate, the higher the probability that you'll acquire pecking-order points.

Sincerely yours,
Miguel Melgar, PE
Sweetwater, FL

(Ed Note: *We doubt that giving kids a chance to go to Electro or Wescon will flood engineering schools with new applicants. However, there is a good chance we will get applicants who really want to be engineers. Every profession has its good and bad points, and youngsters should know about them before they choose career paths. Kids aren't stupid. They'll hear from upperclassmen, friends, and relatives about the decline in engineering jobs, and we'll see a proportionate decline in engineering school enrollment. But if engineering is such a rotten profession, why are so many people still in it?)*

Errata

An editing error crept into a February 5 news break (pg 19), which drastically affected the frequency range of the FS-30, a digitally programmable CMOS frequency synthesizer from Analytic Instruments (Dallas TX). The $195 device offers a 20-*mHz*- to 31-MHz range, not the 20- to 31-MHz range as printed.

Please note the following corrections to the November 13, 1986, issue of EDN. In the article "Use of check list prevents problems in TTL systems" (pg 253), item 25 cites an incorrect number (9052) for a monostable device. The correct number is 9602.

Further, a paragraph in the New Products section (pg 329) erroneously states that the SHM-91 dual S/H amplifier from Datel features an acquisition time of 2 msec. In fact, the device's acquisition time is 2 μsec.

Finally, the phone number given on pg 347 for Sprague Electric Co is incorrect. The correct number is (603) 224-2755.

YOUR TURN

EDN's Signals and Noise column provides a forum for readers to express their opinions on issues raised in the magazine's articles or on any topic that affects the engineering industry. Send your letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.

Where to find almost any test environment on Earth. Plus a few that aren't.

Lockheed's Environmental Test Laboratory provides complete environmental, electromagnetic interference/compatibility and stress screening services on a 24-hour-per-day basis. All at one location.

We have 26 years' experience testing all types of equipment under carefully controlled laboratory conditions. Whether your specifications are military or commercial, we're fully equipped to handle your climatic/atmospheric simulation, structural, enclosure or noise testing, and much more.

Call Jack Glavine at (201) 757-1600 Extension 2267 or 2227 with your equipment test specifications. However impossible they may seem.

Lockheed Electronics

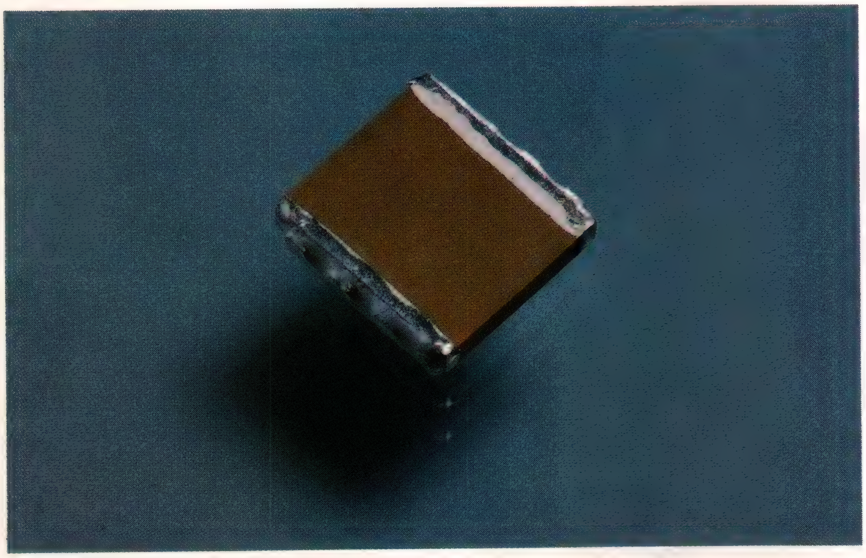
Innovation
Giving shape to imagination.

CIRCLE NO 14

Decoupling V

AVX TechFile Series

TECHNICAL INFORMATION FROM THE LEADER IN MLCs



Power-Entry Decoupling

Replacing Electrolytics in Surface Mount Applications

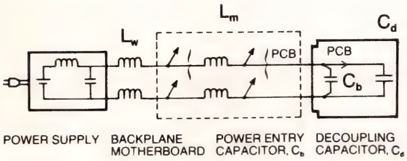


Figure 1. Power supply to printed circuit board (PCB)

In a typical power distribution system (Figure 1), the power-entry capacitor C_b is a relatively large-valued capacitor near the power-entry point on the PCB.

These board level decoupling applications or power-entry capacitors have been dominated by aluminum and tantalum electrolytic capacitors, but the push to surface mount configurations presents major problems in the use of these electrolytic capacitors.

Now, high value, small physical size MLCs offer an excellent alternative to electrolytics. MLCs are compatible with surface mount processing. This allows the designer to take advantage of the lower ESRs and ESLs of MLCs to prevent transmission of PCB-generated noise to the backplane/motherboard and power supply.

Test Results

Figures 2 and 3 compare the response of a tantalum capacitor with an MLC to a leading edge of 200 mA/nS. The tantalum shows an inductive voltage of 2.0V versus the MLC's 0.4V.

This reduction in the ESL of the power entry capacitors through the use of MLCs relative to the conventional approach of using tantalums results in greater than 15 dB noise reduction in the critical range of clock-harmonics falling between 50 MHz and 150 MHz (see Figure 4). This is the most troublesome frequency range in meeting FCC emission requirements, as that noise will eventually find its way to an "antenna" (I/O cables, etc.) and cause out-of-spec emissions problems.

Conclusion

The value of the power-entry capacitors can be reduced by using larger value circuit level decoupling capacitors (0.1μF). In effect, some of the total capacitance on the PCB is shifted from the power entry capacitor, C_b, to larger-valued decoupling capacitors, C_d.

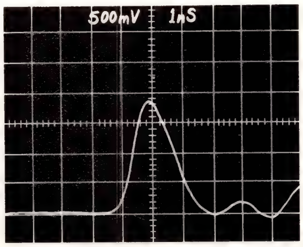


Figure 2. 5.6μF Tantalum

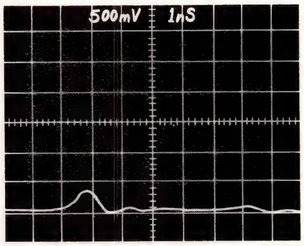


Figure 3. 7.5μF Ceramic MLC

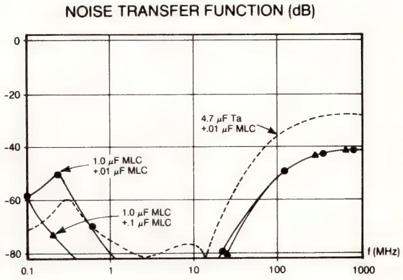


Figure 4. Noise transfer function from switched gates to power entry point (Ferrite bead used on power feed line in all cases)

☐ Please send me the AVX Technical paper "Improved Noise Suppression via MLCs in Power-Entry Decoupling."

☐ Please send me literature describing AVX MLCs.

Name________________

Title________________

Company________________

Address________________

City________________

State________Zip________

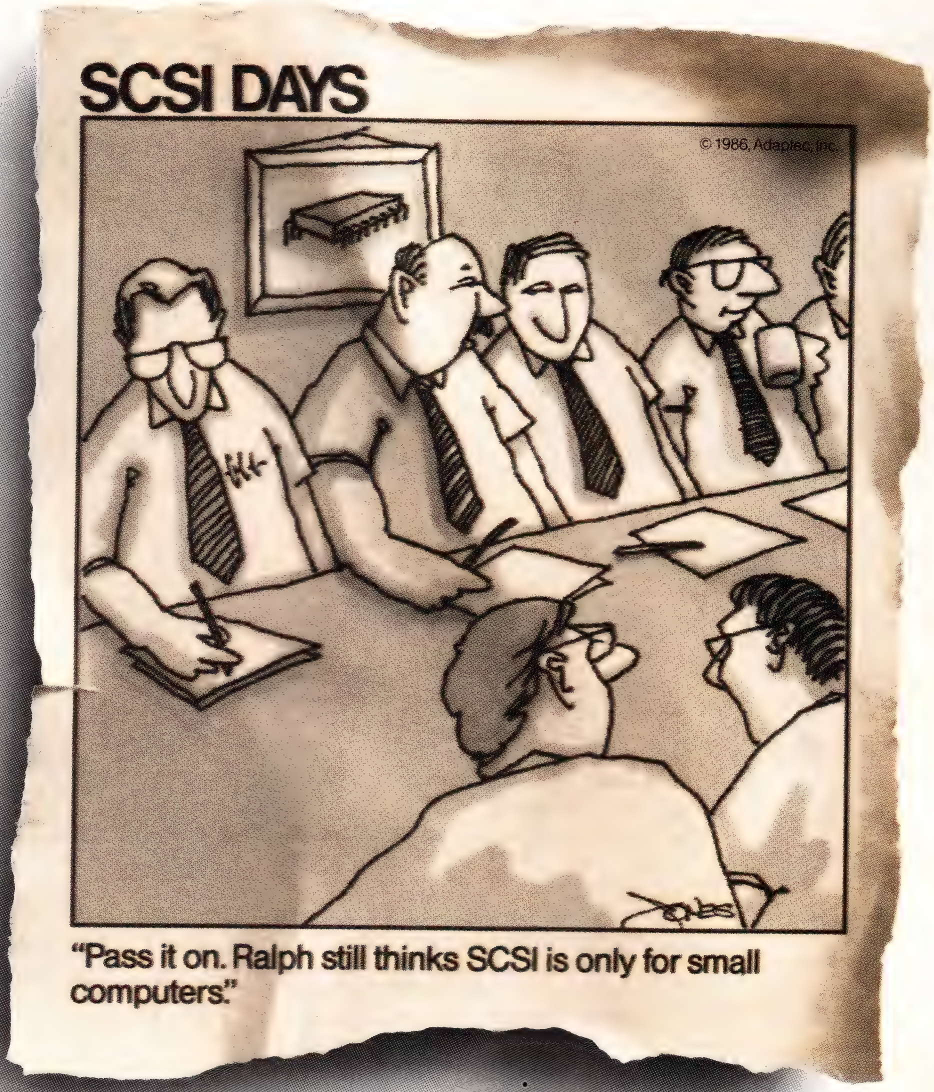
Phone________________

EDN031887

Send to: AVX Corporation
P.O. Box 867
Myrtle Beach, SC 29577

AVX **Technology For The Times**

For additional information circle 11



SCSI DAYS

© 1986, Adaptec, Inc.

"Pass it on. Ralph still thinks SCSI is only for small computers."

MULTIBUS is a registered trademark of Intel Corp. UNIX is a trademark of AT&T Bell Laboratories, Inc.

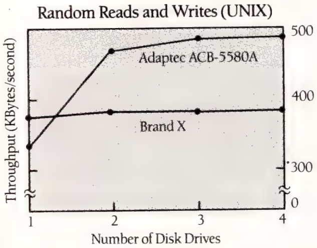
SCSI, the Small Computer Systems Interface, is far more powerful than the name implies.

To prove it, we asked an independent consultant to compare the throughput of our SCSI to SMD controller (with our MULTIBUS® host adapter) to one of the fastest MULTIBUS SMD controllers around. So he ran a series of UNIX™ benchmarks doing random reads and writes.

The outcome? With two drives connected, we beat them. With four drives and more than a gigabyte on line, we hung them out to dry.

How did we do it? Adaptec's multithreading, that's how. It let us execute tasks on each drive at the same time. Of course features like 1:1 Interleave and Disconnect/Reconnect didn't hurt.

What's more, our controllers bring the same kind of performance to ST506, ESDI or even 15MHz ESMD drives. So now, whatever your application, you can get a faster controller with the added flexibility of SCSI, for a lot less money.

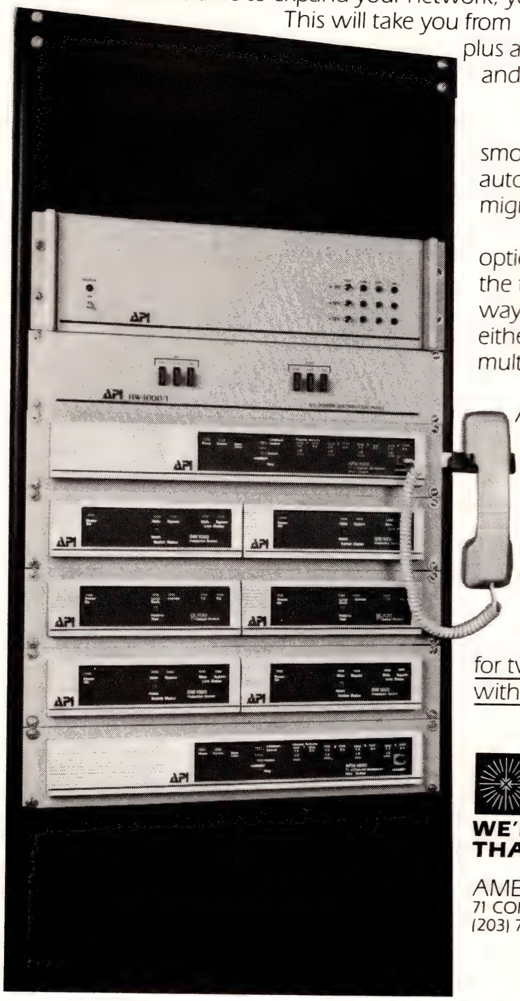


For complete benchmark results and more about our line of high-performance SCSI controllers, call **408-432-8600**, ext. 400. Or write Adaptec, Marketing Dept. (TH), 580 Cottonwood Drive, Milpitas, CA 95035.

And start thinking big.

adaptec

CIRCLE NO 158



THIS T-CARRIER WILL ACTUALLY CARRY YOU INTO THE FUTURE.

You begin with our DL1120 limited-distance modems (up to 20,000 meters). When it's time to expand your network, you add our AFM4500 multiplexers. This will take you from 1 to 4 independent T1 channels, plus an asynchronous supervisory channel and—this is unique—a voice channel. On one line.

Finally, to keep this traffic flowing smoothly, our SW1000 switch will automatically by-pass any break in the migration path.

By using low-cost consumer-type optical sources, API has pioneered the technology that gives you a reliable way of transmitting T1 signals through either single or multi-mode fiber.

The DL1120/AFM4500/SW1000: API's new Modular T1 System. Which means you can build all this capacity, reliability and economy all at once . . . or later on.

ASK ABOUT OUR NEW MODULAR T1 SYSTEM AND OUR OTHER OFF-THE-SHELF T1 AND ETHERNET PRODUCTS.
800-626-5745

"And we'll warranty everything for two years—to insure our future with you." James A. Walyus, Chairman and CEO

API
WE'LL TAKE YOU FURTHER THAN YOU'VE EVER GONE BEFORE

AMERICAN PHOTONICS INC.
71 COMMERCE DRIVE, BROOKFIELD CENTER, CT 06805
(203) 775-8950/8955

CIRCLE NO 15

DID YOU KNOW?

Half of all EDN's
articles are staff-written.

EDN

CALENDAR

Hands-on Programming in C, San Diego, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. March 24 to 27.

Internepcon/Semiconductor Korea '87, Seoul, Korea. Cahners Exposition Group, Box 70007, Washington, DC 20088. (301) 657-3090. March 26 to 28.

Ninth Annual Rocky Mountain Inventors Congress Conference, Denver, CO. Don Margolis, (303) 443-3818. March 27 to 28.

Interface '87, Las Vegas, NV. Interface Group, 300 First Ave, Needham, MA 02194. (617) 449-6600. March 30 to April 2.

ADEE West '87, Anaheim, CA. Cahners Exposition Group, 1350 E Touhy Ave, Des Plaines, IL 60017. (312) 299-9311. March 31 to April 2.

Hands-on Programming in C, Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. March 31 to April 3.

Real-time Operating Systems: A Hands-on Workshop, Boston, MA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. March 31 to April 3.

Defense Communications Agency Forecast to Industry, White Oak, MD. Armed Forces Communications and Electronics Association NOVA Chapter, Computer Sciences Corp, 6565 Arlington Blvd, M/C DCA/AFCEA, Falls Church, VA 22046. April 1 to 2.

Microtronics '87, Hannover, West Germany. Hannover Fairs USA, Box 7066, Princeton, NJ 08540. (609) 987-1202. April 1 to 8.

POWER-ONE
Has Built Over 4,000,000 Power Supplies. We Know What Really Counts.

1. CUSTOMER SATISFACTION Through Quality... No one builds in quality like POWER-ONE. That's the main reason we've been voted *Buyers' Top Choice in OEM Power Supplies** for three years running.

2. CUSTOMER SATISFACTION Through Pricing... Regardless of quality, there are no better prices in the industry than POWER-ONE. Just honest, fair, competitive pricing, day in and day out.

3. CUSTOMER SATISFACTION Through Selection... At POWER-ONE you have a choice. Whatever your requirements call for—switching, linear, or custom designs—you get the technology your need. Without the worry of being stuck with second best.

4. CUSTOMER SATISFACTION Through Service... Our experienced factory and field sales force keeps POWER-ONE service close at hand, whatever your location. This means fast, competent response to your every power supply need, worldwide.

5. CUSTOMER SATISFACTION Through Delivery... Our entire line is stocked worldwide...not just a few selected models. Every POWER-ONE standard model is available today, ready for immediate shipment. No delays, no costly long lead-times. Just on-time delivery.

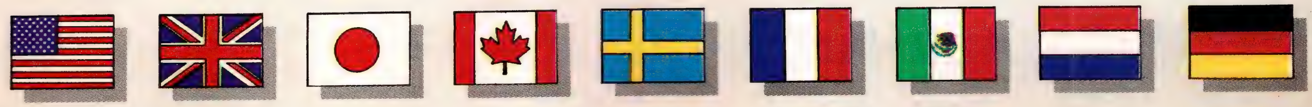
*Electronic Buyers' News, Annual Top 100 Component Suppliers Survey...1984, 1985, 1986.

For our new 1987
Catalog and brochure on
POWER-ONE capabilities,
CALL OUR TOLL-FREE
LITERATURE HOT-LINE:
(800) 235-5943, Ext. 113.
From California:
(800) 421-3439, Ext. 113.

"Innovators in Power Supply Technology"

POWER-ONE
D.C. POWER SUPPLIES

POWER-ONE D.C. POWER SUPPLIES
740 Calle Plano • Camarillo, CA 93010-8583
Phone: (805) 987-8741 • (805) 987-3891
TWX: 910-336-1297 • FAX: (805) 388-0476



CIRCLE NO 150

Optical encoders are an available option for *every* Pittman® motor and gearmotor. Brush-commutated motors with continuous duty torques from 1.2 oz.-in. to 32 oz.-in. High performance ELCOM® brushless servo motors with continuous duty torques from 6.4 oz.-in. to 52 oz.-in. Spur gearheads to 500 oz.-in. — Planetary gearheads to 125 lb.-in.

Mate any of these motor-encoder assemblies to your choice of a modern digital motion controller and get precision shaft positioning with programmable acceleration and slew rates without lengthy and complex servo loop development.

Call [215] 256-6601 today.

PITTMAN
HARLEYSVILLE, PA 19438-0003 USA
A DIVISION OF PENN ENGINEERING & MANUFACTURING CORP

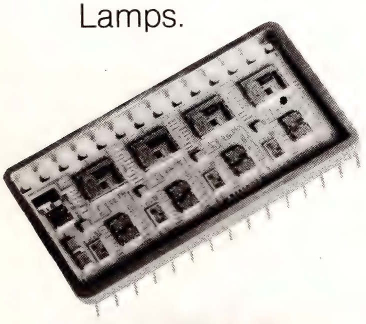
© Pittman, 1986 31-C

CIRCLE NO 16

HYBRIDS

BI means custom microcircuits.

We offer twenty years experience in thick and thin film hybrid design and manufacturing to the highest military reliability levels. When you design in Beckman Industrial Corp., you get the responsiveness and quality that's made us an important element in a wide variety of highly successful programs such as Standard Missile II, Captor, Stinger, Harpoon and Lamps.



For applications assistance or our Microelectronics capability brochure, call
(714) 447-2333.
Fax 714-447-2400.

Beckman Industrial™
4141 Palm St., Fullerton, CA 92635

CIRCLE NO 17

CALENDAR

Invitational Computer Conference, Nashua, NH. B J Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. April 2.

Conference on Human Factors in Computing Systems and Graphics Interface, Toronto, Canada. Wendy Walker, Conference Coordinator, Computer Systems Research Office, University of Toronto, 10 Kings College Rd, Rm 2002, Toronto, Ontario, Canada M5S 1A4. (416) 978-5184. April 5 to 9.

Electro/Mini Micro Northeast, New York, NY. Electronic Conventions Management, 8110 Airport Blvd, Los Angeles, CA 90045. (800) 421-6816; in CA, (800) 262-4208. April 7 to 9.

Nepcon Southeast, Orlando, FL. Cahners Exposition Group, Box 5060, Des Plaines, IL 60017. (312) 299-9311. April 7 to 9.

Annual Electrical Overstress Exposition, San Jose, CA. EOE, 2504 N Tamiami Trail, Nokomis, FL 33555. (813) 966-9521. April 21 to 23.

Modern Electronic Packaging, Washington, DC. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. April 21 to 23.

Real-time Operating Systems: A Hands-on Workshop, Los Angeles, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. April 21 to 24.

Invitational Computer Conference Computer Graphics Series, Munich, West Germany. BJ Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. April 23.

Introducing OptiLab™:

The Complete Microprocessor Development Toolbox.

You need the right tools to speed completion of your project and improve its quality.

That's why we created the OptiLab toolbox. The tools you want for beginning-to-end development and optimization of microprocessor code. OptiLab's fully-integrated, PC-based system lets you debug, analyze, modify, optimize, and test code in a seamlessly integrated environment. You can add your own cross-assembler, too.

The star of the OptiLab is Program Performance Analysis that helps you uncover invisible bugs, eliminate unneeded code, and cure program inefficiencies. OptiLab runs in real-time, is non-intrusive, and gives you outstanding performance at a remarkably low price.

There's more. OptiLab's 48-channel analyzer lets you track bus state activity and trap bugs fast. Monitor your software as it executes in real time with the full-featured 8/16-bit In-Circuit Emulator. Send test patterns with the Input Stimulus Generator and observe their effects. With the built-in EPROM Programmer, you can program devices without leaving OptiLab.

Orion offers you ready support for more than 150 different microprocessors. MicroTargets™ allow you to run and test your software even before you have working hardware. And our crack team of Applications Engineers is standing by if you need assistance.

But here's the real news. OptiLab is priced under $7,000. Or, you can start with a basic Orion system for as little as $2,995 and add capabilities as you need them.

Call now for complete information on OptiLab or other Orion microprocessor development tools. All Orion products are sold with a 15-day money-back guarantee.

WRITE

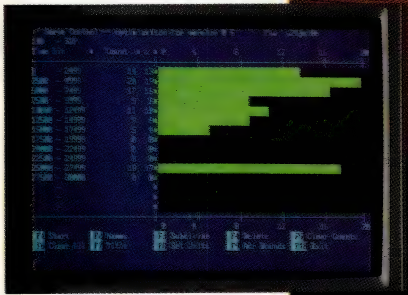
Analyzer
In-Circuit Emulator
Line-by-Line Assembler
Debug Package
Performance Analyzer
Stimulus Generator
EPROM Programmer

OptiLab™

ASSEMBLE
DEBUG
TEST
OPTIMIZE
SHIP

Everything from assembly to final optimization of your software can be done with the OptiLab toolbox.

OptiLab presents a graphical display of actual program performance.



ORION
INSTRUMENTS, INC.

Call Toll Free: 1-800-245-8500
In California: (415) 361-8883

Orion Instruments, Inc., 702 Marshall Street, Redwood City, California 94063, U.S.A. Telex: 530942

CIRCLE NO 156

Now GE/RCA drives

CMOS into the FAST* lane.

Advanced CMOS Logic: the new industry standard that's fast as FAST.

Now, Advanced CMOS Logic (ACL) gives you speed and drive to match FAST. You get all the advantages of CMOS, with less than 3ns propagation delay (AC 00 NAND Gate) and 24mA output drive current.

Outperforms FACT.*

Our ACL is faster than FACT. GE/RCA ACL uses a 1.5 micron channel length N-well CMOS process resulting in an on-chip gate delay of only 0.7ns.

FAST speed, CMOS low power.

ACL power dissipation is typically less than 25% of a FAST bipolar device. ACL dissipates less than a quarter of one Watt while switching, compared to one full Watt for a FAST IC (transceiver operating at 5 MHz). Quiescent power savings are even more dramatic. ACL idles at 1/1000 the power of a FAST IC (.5mW vs. .5W).

And with lower heat dissipation than bipolar, you can expect ACL to perform more reliably than FAST and AS.

Latch-up and ESD Protection.

Latch-up concern is virtually eliminated. ACL uses a thin epitaxial layer which effectively shorts the parasitic PNP transistor responsible for SCR latch-up.

And new dual diode input/output circuit provides ESD protection in excess of 2KV.

High Rel and macrocells, too.

Most ACL designs from GE/RCA will be available in our macrocell library for standard cells. And we'll have High Rel versions screened to MIL-STD-883 Class B coming soon.

Expanding product line.

Our line already includes 27 of the most popular types, in both AC and ACT (TTL-compatible) versions. And 77 more types will be available in 1987.

Prices comparable to FAST.

Our ACL line is priced comparably to FAST, so your savings with CMOS low power pay for the cost of switching.

Start your sampling today.

Put yourself ahead in the technology race with free samples. Samples must be requested on company letterhead. Write: GE/RCA Solid State, Box 2900, Somerville, NJ 08876.

For more information, call toll-free: 800-443-7364, extension 11. Or contact your local GE/RCA sales office or distributor.

---

*FAST and FACT are trademarks of Fairchild Semiconductor Corp.

RCA

For workstations that thrive in a multivendor

HP's powerful family of technical workstations fits right in with your present computing resources, as well as those added in the future. With industry standard networking, operating systems, and languages. *Plus* hundreds of advanced application packages, and performance extras to give you the competitive edge in all of your engineering and technical activities.

Our solutions are implemented on one of the industry's largest technical computer and workstation families. It consists of the HP Technical Vectra PC, the HP 9000 series 200/300/500, and the new model 840 Precision Architecture Computer.

Full UNIX System V compatibility.

HP's technical workstations use AT&T's System V UNIX operating system with Berkeley 4.2 enhancements and HP improvements. The result is a standard tuned to the workstation environment with windowing, real-time I/O extensions, graphics, six languages and other extras.

The networking you need.

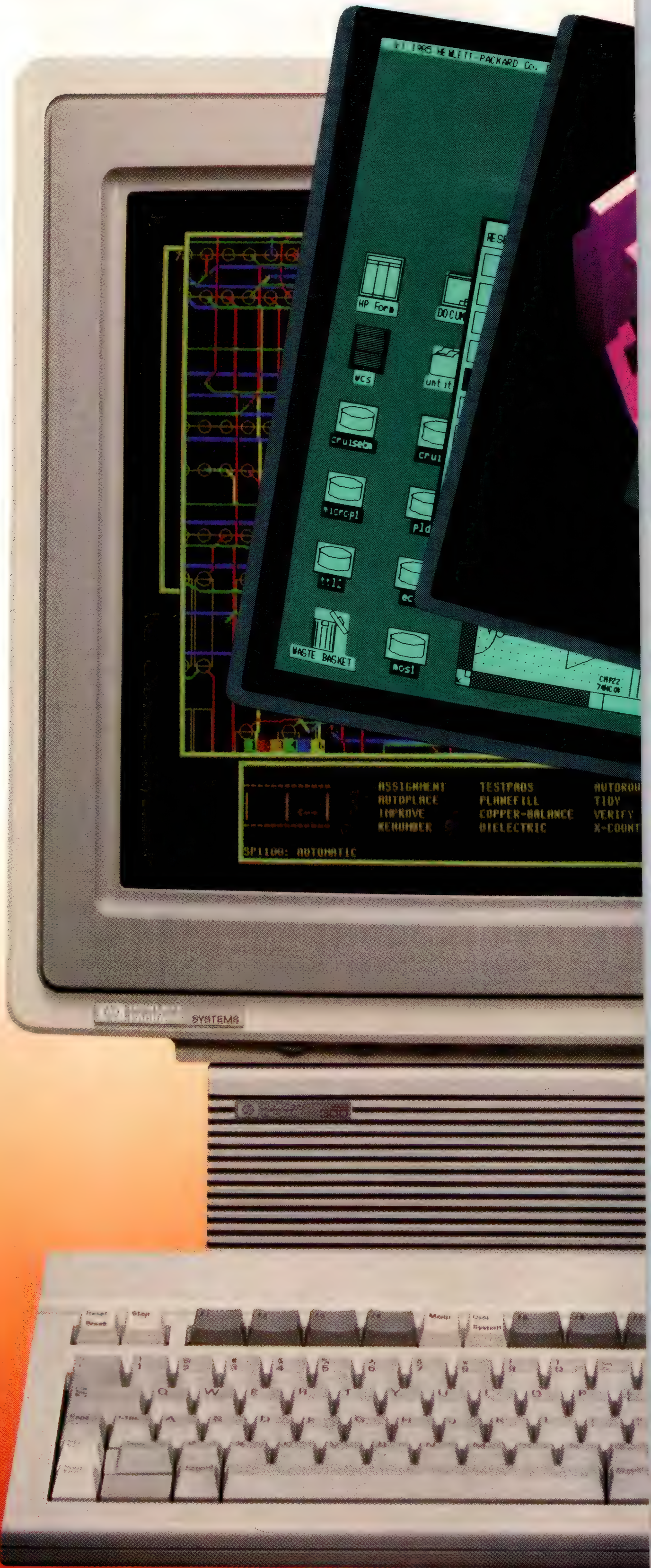
HP offers the networking to unify design, test, manufacturing, and technical office automation in your company. You'll have ARPA and Berkeley services and TCP/IP on Ethernet** and IEEE 802.3 to provide connectivity with IBM, DEC, and other vendors' products.

AI power without special AI machines.

You get everything you expect in a multipurpose workstation, plus the ability to run Artificial Intelligence on the same machine. Based on Common Lisp, it lets you harness AI power for accelerated software development. You can also get premier expert system tools from companies such as Intellicorp and Teknowledge.

Wide range of graphics solutions.

The choice is yours...from low-cost monochrome to high-resolution color monitors...from simple report



run UNIX* systems and environment, talk to HP.

graphics to 3D solids modeling. There are industry standards like GKS and ANSI Computer Graphics Virtual Device Interface (CG-VDI), to protect your investment by making your existing software portable. HP's accelerated graphics solutions are highly modular, so you can upgrade whenever you choose.

Hundreds of application packages.

Specialized technical applications? No problem. HP's application packages include logic and analog CAE, PCB CAD, microprocessor software development, 2D design and drafting, 3D solids modeling and finite element analysis, documentation and report generation, and database management. New software packages are constantly being added for an even larger selection.

HP—protecting your investment.

Buying HP's solutions is not only a smart decision initially, but it provides the added benefit of lower cost of ownership that reflects our commitment to quality and service. For more information, call your local HP sales office listed in the telephone directory white pages.

Tap HP's DATA-LINE for complete facts...instantly!

For on-line information 24 hours a day, use your computer, modem, and HP's DATA-LINE. Dial 1-800-367-7646 (300 or 1200 baud, 7 bits even parity, 1 stop bit). In Colorado call 1-800-523-1724.

---

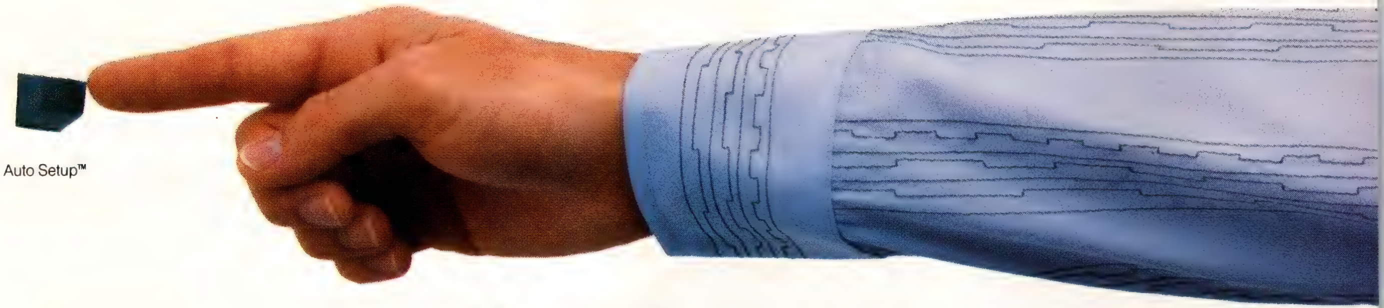
*UNIX is a trademark of AT&T. **Ethernet is a trademark of Xerox Corporation.

HEWLETT PACKARD

DS15603B

CIRCLE NO 149

The easiest setup in logic analysis?



You just put your finger on it.

Gould introduces Auto Setup™: from zero to 200 MHz in 26 seconds.

Gould already makes the industry's most powerful logic analyzer—the K450. Now, we make the easiest to use—the K450 with Auto Setup.™

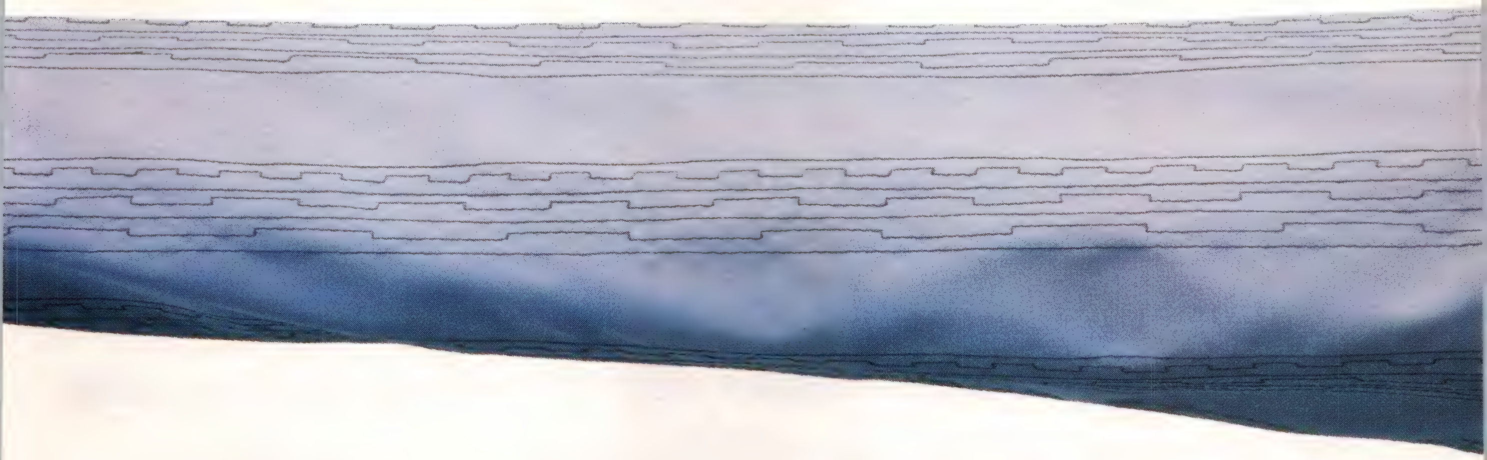
Press a key, wait less than 30 seconds and, voila, you're ready to go.

What does Auto Setup™ do for you? Everything but connect the probes.

It checks probes for activity, sets the threshold, chooses the appropriate clock speed and arranges the channels on the screen, so that you can see exactly what you captured… instantly.

All high speed channels (24 at 200 MHz, 48 at 100 MHz) give you resolution to 5 ns. Sixteen interactive levels of Trace Control™ recognize and record the exact state/timing event you want. No other analyzer offers better triggering.

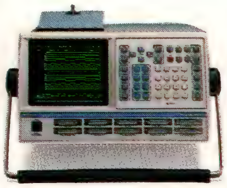
Gould K450. The industry's most sophisticated analyzer is now the easiest to use.



An ample 4K memory, Auto Save and a built-in disk drive give you all the capability you're likely to need. And of course, there's "Help" when you need it.

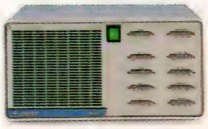
But the K450 is only the leader in an extensive Gould logic analyzer family. For nearly 20 years, we've been building special models to do special applications. One will be right for you.

For comprehensive data sheets on any Gould product, call TOLL-FREE (800) 538-9320. Or write: Gould Inc., Test & Measurement Group, 19050 Pruneridge Ave., Cupertino, CA 95014. Act soon—Auto Setup™ isn't the only hot button we have.

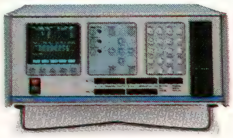


K115—The µP Analyzer. Up to 72 ch., 200 MHz on 8 ch. Disassemblers for all popular µPs.

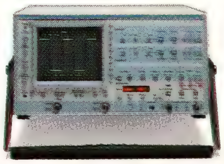
K500—The Mainframer. 500 MHz on all 8 channels! The super computer analyzer.



K125—for CAE/CAD/ATE verification. Also does functional testing of your production units.



PG4064—Data Word Generator. Simulates data words up to 64 channels wide, even bit slice µPs.



4070—Digital Storage Oscilloscope. The perfect 100 MHz analog oscilloscope replacement.

GOULD
Electronics

SIEMENS

**Ahead through quality.
Right from the start. From Siemens.**

If you want to be out in front in electronic components, you have to be out in front in quality and reliability. And from the very start. The quality that is achieved as early as development has a decisive effect on the ready component. Ultramodern CAD helps us to develop faster, to simulate circuits and thus to eliminate sources of error at the design stage.

Our quality-assurance system is all-encompassing and consistent right through to the end-product: incoming inspection of materials, production controls, constant checks of supply quality, reliability tests for reaction to environment and longterm behavior, and quality in service too.

This is quality guaranteed by 27000 employees. And billions of marks for research, development and quality assurance. This is the sort of foundation Siemens customers can build on. Worldwide.

Components from Siemens –
tops in technology,
quality and reliability.

Siemens introduced an internal zero-defects sampling plan for ICs in 1985. Which means that the QA team takes a sample of 200 pieces from each lot that is ready for dispatch.

If there is just one defect, the whole lot is sent back for thorough inspection. A lot containing a defect which was detected by a customer may also be returned to Siemens for retesting.

Quality is firmly established throughout our organization. Internal consultation, coordination, communication of experience, cooperation with customers and suppliers, participation in quality audits, training, representation on international committees are just some of the tasks of the quality departments, which operate quite independently of the manufacturing process.

Quality of components also means using experience gained in their use by our customers all over the world and in all climatic zones. Here we have acces to the know-how of one of the world's biggest systems producers: Siemens.

Siemens AG,
Components
Group,
Balanstrasse 73
D-8000
Munich 80.

12/Z032e

Faster!

CMOS at speed.

A few more fast, fast reasons to call for our new databook:

1. New 64K SRAM. 25ns. Seven configurations—including bit-wide, nibble-wide, byte-wide, separate I/O, and all with low, low, power. As low as 50 mA active at 45ns.

2. New 128K Reprogrammable PROM. 45 ns. 100 mA active, 30 mA standby.

3. New 64 x 9 and 64 x 8 FIFOs. 35 MHz. Virtually no bubble through. Cascadeable.

4. Fastest 22V10 Reprogrammable PLD. 25ns. 55 mA. And we have the board to turn your PC into a PLD/PROM programmer, too!

5. *High speed CMOS SRAM.*

6. *High speed CMOS PROM.*

7. *High speed CMOS PLD.*

8. *High speed CMOS LOGIC.*

9. Fabricated and assembled in our DESC-certified U.S.A. facilities.

This databook, packed with high speed, low power parts, is yours for a phone call.

DATABOOK HOTLINE:

1-800-952-6300, Ask for Dept. C37
1-800-423-4440 (In CA), Ask for Dept. C37
(32) 2-672-2220 (In Europe)
(416) 475-3922 (In Canada)

We illustrate the Lockheed SR-71 Reconnaissance aircraft, holder of the world's air speed record: 2,193 miles per hour. We're fond of speed records. Over 30 of our parts have broken or still hold speed records for integrated circuits.

CYPRESS
SEMICONDUCTOR

Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134.
Phone (408) 943-2666 Telex 821032 CYPRESS SNJ UD, TWX 910-997-0753.
PAL is a registered trademark of Monolithic Memories, Inc.
©1987 Cypress Semiconductor

Direct sales costs too much

The pc-board layout packages described in this issue's cover story (pg 138) cost $1000 to $15,000. Until recently, similar software could cost you $30,000 or more. We asked pc-board layout vendors how prices could come down so much, so quickly. Had purveyors of the high-priced models been raking in enormous profits before?

Whatever the earlier profits, vendors concede that profit margins are less for low-cost packages than for high-cost ones. But suppliers of the low-cost ones attribute their lower prices mostly to differences in sales practices. Instead of sending salespeople to prospective customers, vendors of low-cost layout packages use advertisements, distributors, and the mail to reach customers.

The main drawback to using salespeople is the cost incurred to keep them on the road. One company reported that it had spent about $150,000 per year to maintain one salesperson's job. Obviously, when you buy a product from a company that uses direct salespeople, you're indirectly paying for part of those high costs.

If a salesperson adds value to a product, then he or she is worth the extra cost. However, many electronics companies employ salespeople with no engineering training; those people don't understand their products well enough to add that extra value. Such salespeople can even lack the expertise to understand their companies' promotional literature.

That's not to say you'll never talk to qualified salespeople. But you can learn at least as much as they know from other sources. First, you can read a company's literature and spec sheets. You can also test the product. Software vendors will often send out demonstration disks. Many vendors rely on distributors, who let you run programs in their offices. You'll learn more by trying a program than by listening to someone tell you how wonderful it is.

Alternative sales approaches can thus provide more results per sales dollar than direct sales. Many electronics firms, for example, are following a trend started by the garment industry: They're mailing videotapes that describe their products. The companies that apply such innovative marketing techniques and therefore offer products to you at the lowest cost will be the ones to survive.

Eva C. Freeman

Eva Freeman
Associate Editor

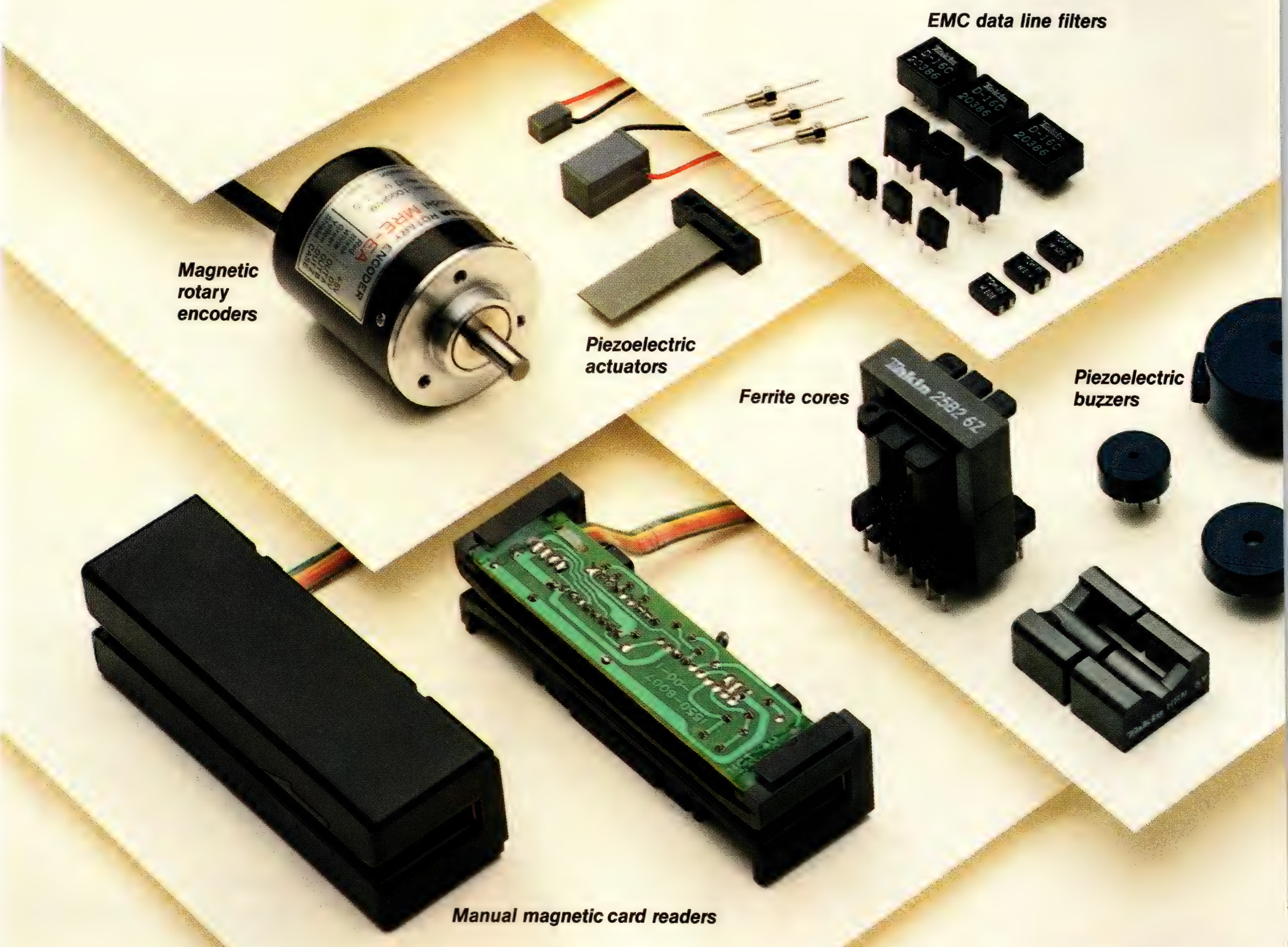
Electro®

Electronic Show and Con

What else you could ask fo From Tokin.

What more dare you ask from a company that time and again during the past half century has produced outstanding new breakthroughs in the communications industry? Well, you might ask for ferrite cores for switching power supplies, EMC data line filters, piezoelectric buzzers and actuators, magnetic card readers, and magnetic rotary and linear encoders—but al much, much more.

Tokin has many new products to offer you, an look forward to showing them to you at Electro/8 April 7—9, 1987, in New York City. We'll be in boo #2079 and #2081.



Toki

Tokin Corporation

Head Office: Hazama Bldg., 5-8, Ni-chome
Kita-Aoyama, Minato-ku, Tokyo 107, Japan
Tel.: Tokyo (03) 402-6166 Telex: 02422695 T

Tokin America Inc.
2261 Fortune Drive, San Jose, California 95
U.S.A. Tel.: 408-946-4887

You can reach our agents by phone:
London 01-837 2701; Paris 1-45 34 75 35;
Milan (0331) 678.058; Munich (089) 5164-0;
Seoul (02) 777-5767; Taipei (02) 7311425;
Hong Kong 3-315769; Singapore 747-8668

CIRCLE NO 147

HE BEST OF BOTH WORLDS

T HE BEST QUALITY PRODUCTS.
DE IN AMERICA.

Beginning in 1984, our Roseville, California
cation and manufacturing facility developed
w standard for comparison: 50 failed parts
million (ppm), or less.

Currently building high-volume, 1.5-micron-
nology memories, digital signal processors,
microcomputers, NEC Electronics reaches a
level of commitment for traditional Japanese
ity made in America. With highly automated
ication, assembly, and test, we meet your
in-time delivery requirements with the best
ity products to give you an uncomplicated
rce.

Improving Customer Service

The next phase of development at Roseville
udes a complete gate array capability that
give you even better turnaround time and
trol of your customer-specific ICs. Combined
existing and new design centers in major
nology areas, NEC Electronics offers
plete customer service that takes you from
gn to high production with the leader in
ldwide capacity of high-technology products.

The Uncomplicated Choice

Because of the commitment made in 1981,
Electronics now offers you an uncompli-
ed choice to meet all your semiconductor
irements. For the best of both worlds call
00-632-3531. In California, call **1-800-632-3532.**
write to NEC Electronics Inc., 401 Ellis Street,
Box 7241, Mountain View, CA 94039.

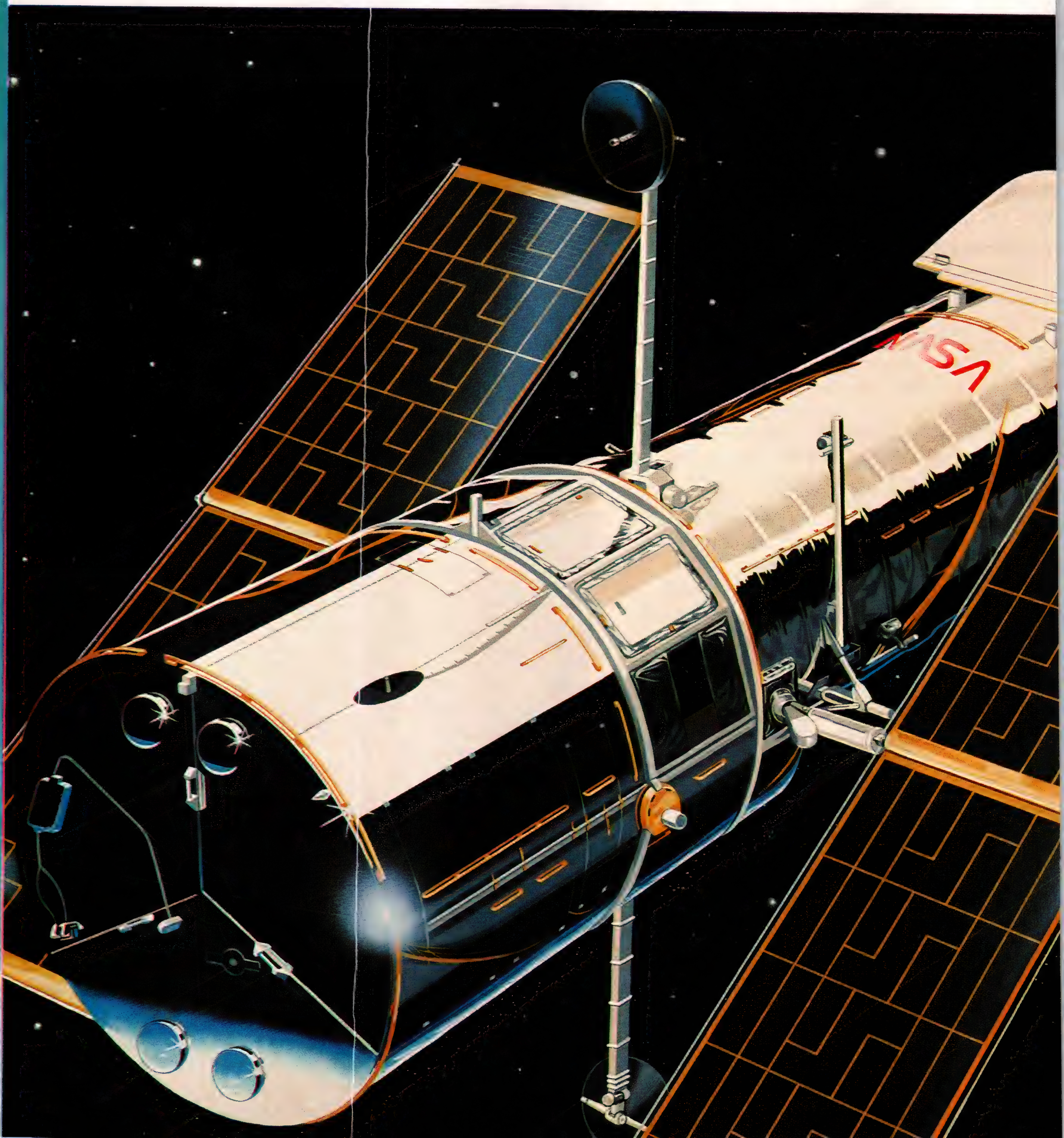
right 1987 by NEC Electronics Inc.

NEC Electronics' 170,000 square foot fabrication and manufacturing facility in Roseville, California

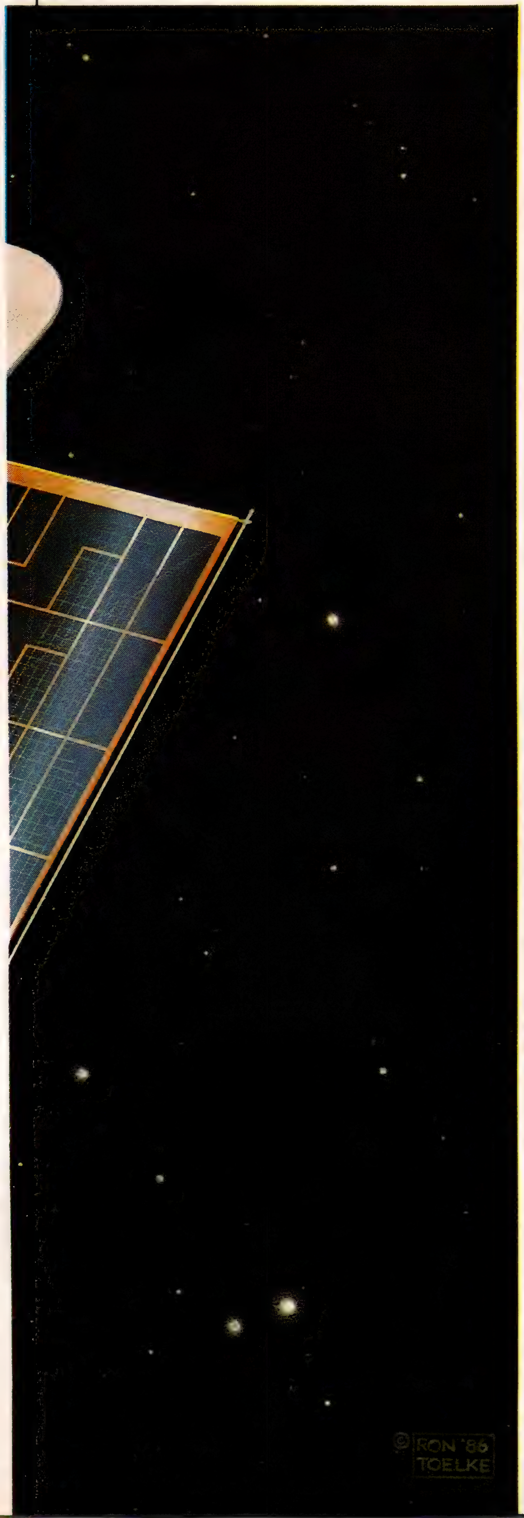
CIRCLE NO 155

NEC

BEFORE THEY TRAVEL AT 17,500 MPH
THEY TRAVEL IN HARDIGG CONTAINER



For spaceborne telescopes as well as commercial satellites, some of the extremely sensitive components and assemblies are shipped and stored in specially designed Hardigg containers. So, before they travel the vacuum of space, they travel with us.



PROVEN PERFORMANCE

These components needed to be safely contained in an extremely dry environment that could withstand shock up to 30g's. Not only did we meet the challenge, but provided a container that went well beyond the requirements. Just like we have with so many other difficult containerization problems for the commercial marketplace over the last twenty years.

Another example is a container we designed for a very delicate medical diagnostic component to a CAT Scan system. The units are stored and shipped all across the U.S., India, Africa, and Europe. We designed a container that not only protected the crystal elements from mechanical shock but also provided protection from damaging thermal shock as well.

CIRCLE NO 153

PROVEN CAPACITY

The reason we can pr
vide answers to so m
difficult containerizati
problems rests on ou
skillful, know
edgeable Ap
cations Engi
ing staff, and
our complete
manufacturi
capabilities.
engineers ar
shock-mitiga
and environ
tal engineeri
specialists th
live and breathe cont
erization. And our faci
enable us to provide
or low volume quanti
while controlling eve
aspect of the manu-
facturing process; fro
mold making to tooli
and metal
working to
plastic
fabri
catio

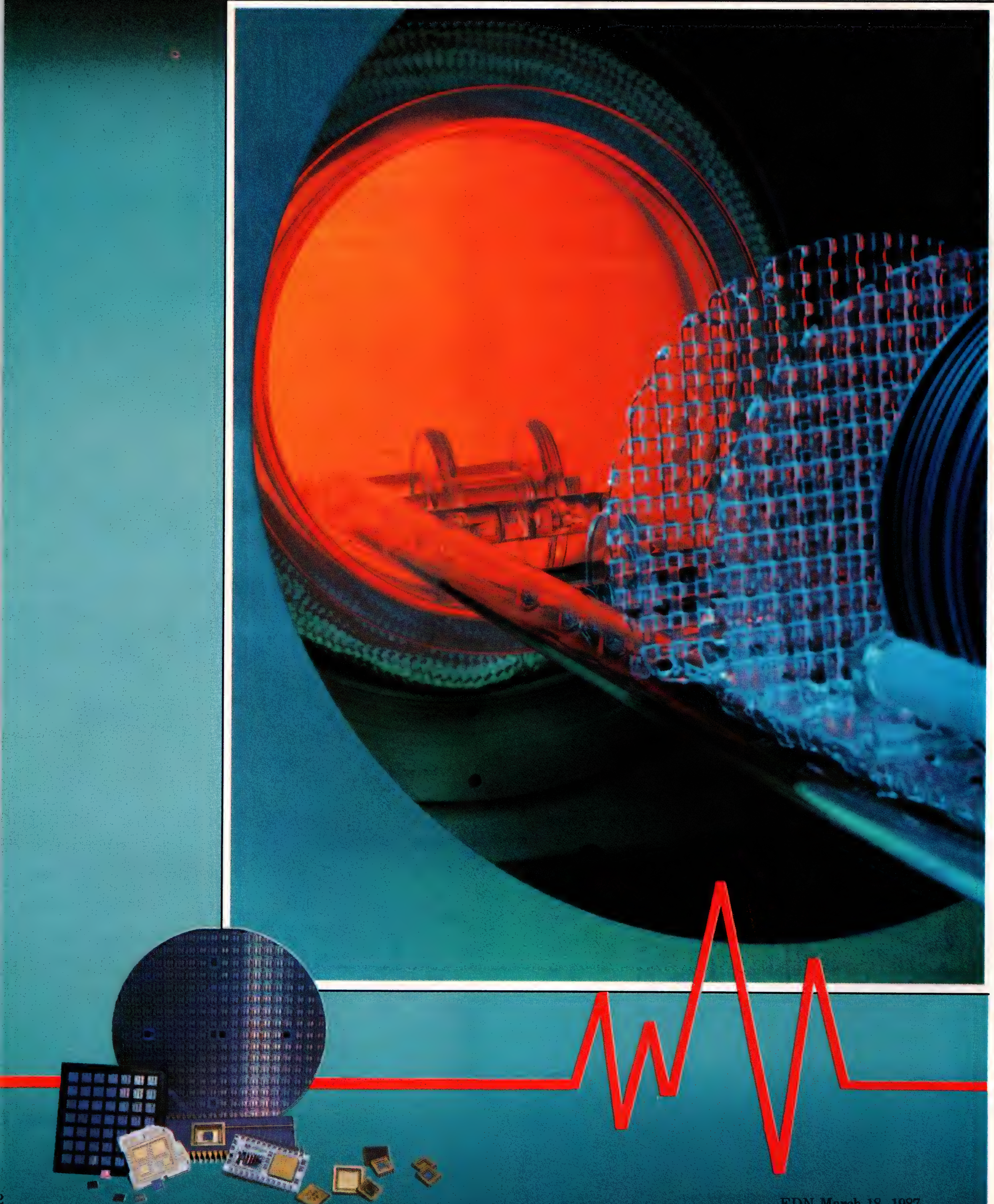
So, before you sen
your next product o
journey to outer or i
space, call the conta
company tha
proven trave
Hardigg.

HARDIGG
INDUSTRIES, I

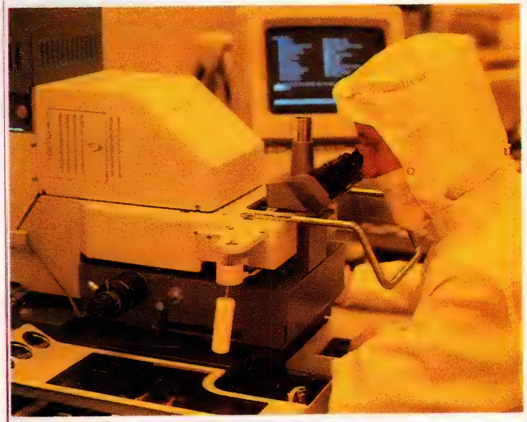
HARDIGG

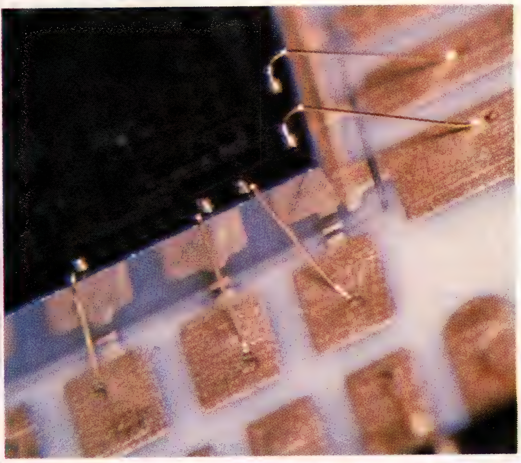
P.O. Box 201
North Main Street
South Deerfield, MA 01
Telephone: (413) 665-2
Telex: 955431

Five good



reasons to choose Micro-Rel for full custom hi-rel ICs





1. **Our experience.** We've been in the business of producing high-reliability electronic components for 14 years. In that time we've developed more than 20 capabilities — including full custom bipolar IC designs since 1975, custom bipolar wafer fabrication since 1976 and linear CMOS IC custom designs since 1980. Since 1984 we've added precision thin film resistors, DI design and fab, double layer metal and rad-hardened ICs, to name just a few recent landmarks.

2. **Our quality certifications.** In addition to high-rel standard 883C, we were one of the first 12 companies to attain certification to 1772 by DESC; we expect to have full 1772 qualification by mid-1987. And we're the only company with multi-layer cofired ceramics capability.

3. **Our technologies.** Our CMOS IC technology includes a 3 micron and 5 micron process. Each has linear and digital standard cells available. Our bipolar technology includes 20V, 40V and 100V processes. Each can utilize dielectrically isolated wafers to eliminate parasitic interaction between devices. Often our ICs can replace many components, reducing manufacturing cost and overall size and weight while increasing performance and reliability.

4. **Our resources.** We have 10,000 square feet of Class 100 or bette wafer fab clean room and 5,000 square feet of Class 100,000 micro-electronic assembly clean room, housed in our 180,000 square foot facility. Of our 600 employees, 50 are devoted exclusively to Quality Assur ance and 150 are engineers experienced in producing custom designs t customers' applications.

5. **Our critical applications background.** Although we are heavily involved in the most current high-rel applications, we earned our spurs as the design and production division of Medtronic, Inc. As such, Micro-Rel is the leading designer and producer of cardiac pacemaker electronics. You can depend on a company that's used to delivering the highest levels of quality and performance.

Of course there are many more reasons to choose Micro-Rel for your custom ICs. But we hope these five will convince you that Micro-Rel is fully capable of satisfying your most demanding requirements. Reliably - and on time.

Write or call today for our technical bulletins. For good reason.

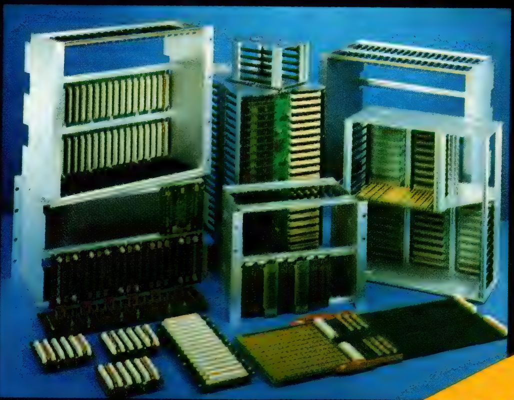
Micro-Rel

Division of Medtronic, Inc.
2343 West Tenth Place, Tempe, Arizona 85281
(602) 968-6411 • TWX: 910-950-1941 • FAX: 602-968-9691

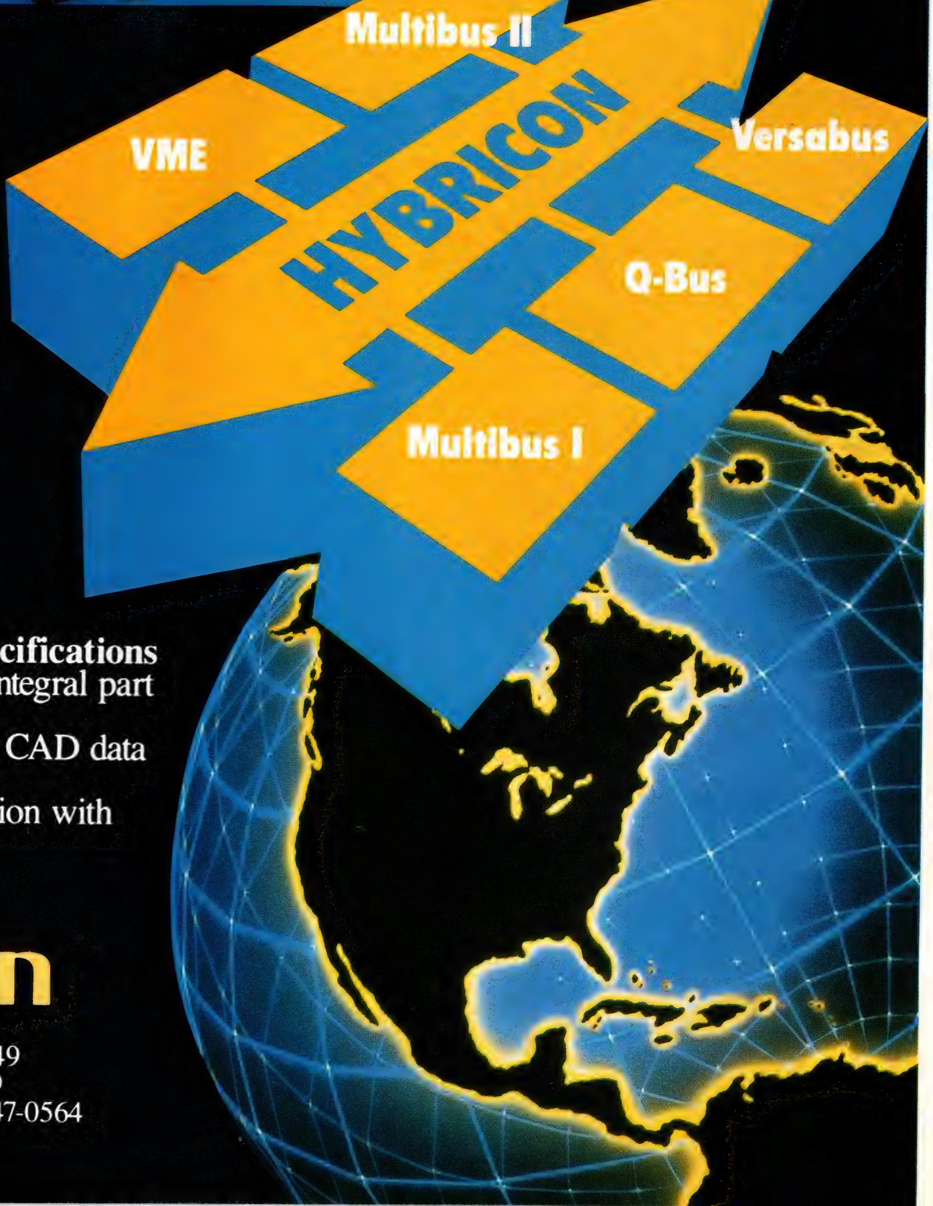
CIRCLE NO 174

No Other Company in the World

..makes more
ackaging/
nterconnection
roducts designed
pecifically for
nicrocomputer
us systems.



- Backplane/Cardcage Assemblies
- Backplanes
- Subracks
- Test Adapters
- Wire Wrappable Boards
- Accessories



ated #1 in Customer Evaluations
Signal transmission integrity
Lowest propagation delay
Lowest crosstalk
Highest power rating

roven Quality
Quality of design
Quality of manufactured product
100% computer tested
Traceability
Five year limited warranty

n Time Delivery
Order tracking
Effective shop floor control
IT account reporting

elivered to Exact Customer Specifications
Customizing to special needs is an integral part of the Hybricon process
Cost effective: Starts from extensive CAD data base
Interactive: Continuous communication with customer

on't Settle for Less...
go with Hybricon

12 Willow Road / P.O. Box 149
Ayer, MA U.S.A. 01432-0149
(617) 772-5422 TWX710-347-0564

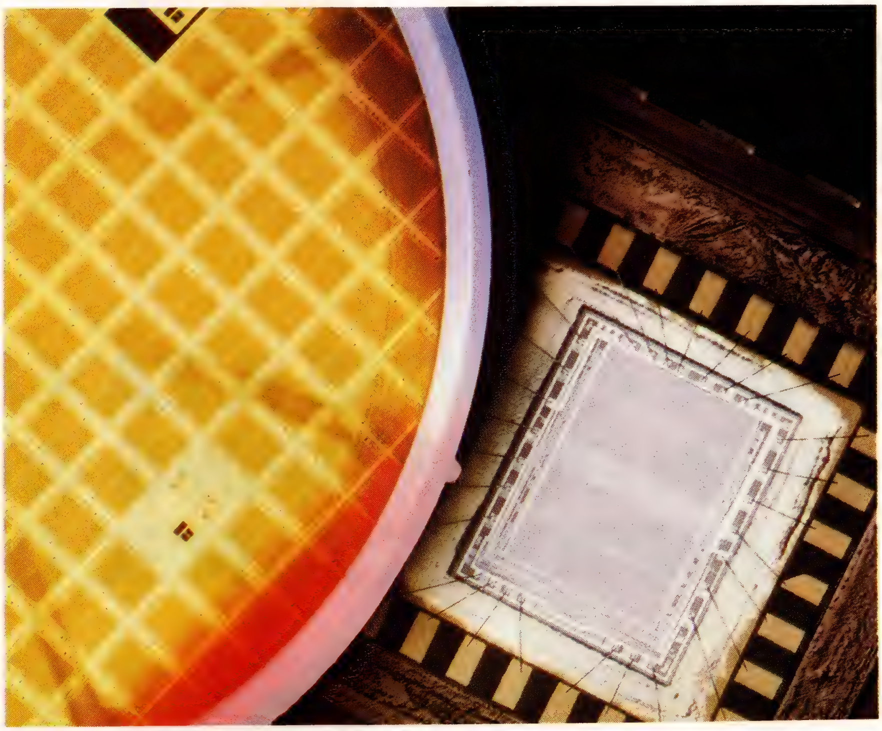
CIRCLE NO 154

Memory-based CMOS FIFO buffers sport large capacities, rival the speed of bipolars

Peter Harold, *European Editor*

The latest generation of 9-bit-wide, memory-based FIFO buffers allows you to implement data-rate buffers or data-delay lines as deep as 4096 words with a single chip. With little or no glue logic, you can cascade the FIFO buffers to obtain greater depth, word width, and data rate. Because most of these FIFO buffers are based on an industry-standard pinout, many FIFO buffers with different depths maintain pin and functional compatibility with one another. Others depart from the norm to provide novel features—for example, serial I/O, programmable status flags, and parity generation/checking logic.

High-capacity FIFO buffers are based on memory architectures rather than on the shift-register technology often used to fabricate their smaller 64-word counterparts. By employing the latest CMOS biport memory-cell techniques, several manufacturers have created high-capacity FIFO buffers that are capable of sustaining input and output data rates of 15 or 20 MHz, rivaling the speed of smaller bipolar parts. In addition, the new buffers' memory architecture eliminates the ripple-through delays that contribute to the input-to-output latency time inherent in shift-register FIFO buffers.



Fabricated in CMOS SOS technology, *the 512×9-bit MA7001 FIFO buffer from Marconi Electronic Devices is inherently free of latch-up problems. If there is sufficient demand, the company will manufacture the part to ESA radiation-hardness specifications.*

A memory-based FIFO buffer has a static-RAM array to which input data is written and from which output data is read. The RAM is addressed by two ring counters, one containing an In pointer and one containing an Out pointer. The In pointer defines the next RAM location that input data is to be written to; the Out pointer defines the next location that output data is to be read from. Internal comparators, which keep track of the difference between the In pointer and the Out pointer, serve to activate status flags that tell you how full the FIFO buffer is. You could think of these FIFO buffers as a hardware implementation of the circular buffer often created in software to queue data into a μP-based system.

Because the data contained in a memory-based FIFO buffer remains static in a memory location, no shifting of data from one memory location to another is required as the FIFO buffer fills and empties. Hence, the input-to-output latency time is only the time taken to perform one write cycle and one read cycle on the RAM—it's typically on the order of 100 nsec or less for a memory-based FIFO buffer fabricated in CMOS technology.

One of the first memory-based FIFO buffers to become commercially available was the 512×9-bit MK4501 CMOS FIFO buffer, which was designed by Mostek before its takeover by Thomson Semiconductors. The buffer's pinout and I/O architecture have subsequently been adopted as an industry standard.

Because a memory-based FIFO buffer's memory array requires no external addressing (all read/write addressing is handled internally by the two ring counters), it's possible to make FIFO buffers of any capacity pin compatible with one another, as long as they have the same data width. As a result, several other manufacturers have announced, or

WHY CHOOSE A ZAX EMULATOR WHEN DEVELOPING WITH HITACHI, MOTOROLA, NEC OR INTEL?

Unparalleled support for true emulation of their microprocessors! Emulation that places you in control of beating your microprocessor design deadlines. User-convenient emulation that makes your job a lot easier.

ZAX offers a broad range of in-circuit emulators conceived, designed and tested to meet your development needs. Emulators for NEC's V40/V50, Intel's 8051/8052 family of microcontrollers, Motorola's 68000/10 and our _newest_ emulators for Hitachi's 6301 and 64180 series. Additionally, we support Z80, 6809/E, 8086/88 & 80186/188, V20/V30 microprocessors and the 8048 family of microcontrollers.

All ZAX Emulators contain an internal processor, "loanable" RAM and extensive debugging mechanisms. They function in real-time and are rated at the same clock speed as the manufacturer's processor. The emulators introduce no added wait states so the prototype program can be executed exactly as the processor would and in the same length of time.

Unparalleled software support is also provided by ZAX. We offer extensive interface and development software for our emulators. All ZAX Emulators interface to a variety of host computers via the optional ZAX-developed communications utility ZICE-II. For development software access, we offer a broad range of products including "C" & Pascal compilers, cross assemblers/loaders and object module librarians.

And should you need a wholly supported host computer, look no farther than ZAX. The ZAX BOX-ER is an economical host computer that's easy to use, delivers abundant processing power, possesses superior memory capacity and supports high resolution graphics for engineering applications. The perfect complement to our emulators.

At ZAX, we're committed to providing you with the tools you need to beat your microprocessor design deadlines. All of our products are backed by a full, one-year warranty which protects you from unnecessary delays. So, whether you're engaged in development using a microcontroller or a variety of microprocessors, call us and we'll show you why you _need_ ZAX's Unparalleled Support.

To order any ZAX Emulator or for more complete information on our product line, call us TOLL FREE at 800-421-0982 (in California phone 800-233-9817) or write to ZAX CORPORATION, 2572 White Road, Irvine, CA 92714. In Europe, call (49) 2162-32034.

ZAX

Zax Corporation

CIRCLE NO 146

are about to announce, MK4501-compatible parts having capacities as great as 4096 words. This compatibility isn't confined to single-device operation either—the parts maintain compatibility even when you use multiple devices to expand FIFO-buffer depth or width. If you expand your FIFO buffer's depth by cascading devices as shown in **Fig 1,** you can use exactly the same interconnection scheme for 4096-word FIFO buffers that you'd use for 512-word FIFO buffers.

Manufacturers offer MK4501-compatible devices in a range of capacities and speed selections. **Table 1** gives salient specs for a number of these devices. You'll find that most of the parts listed in the table as MK4501 compatibles have a Half-Full flag output, which doesn't exist on the MK4501. Generating the Half-Full status flag is actually a second function of the expansion-out pin on most of these devices. You can use the pin as a Half-Full flag output only when you're using a single device to implement your system's FIFO buffer. When you configure multiple devices for depth expansion, the Half-Full output automatically reverts to the expansion-out pin function.

If you're concerned about CMOS latch-up problems—for example, if you're designing equipment for use in electrically harsh environments—consider using Marconi Electronic Devices' MA7001 512×9-bit FIFO buffer. The device, which is pin and function compatible with the Thomson Components-Mostek MK4501, is fabricated in CMOS SOS (silicon-on-sapphire) technology, so it's inherently free of latch-up problems. In addition, even the standard part has a degree of radiation hardness; it can withstand a total-dose radiation level of around 50k rads. If there is sufficient demand, Marconi says, it will produce the part with a radiation-hardness spec that meets the full ESA (European Space Agency) requirements.

Although Mostek took the early lead, it's Integrated Device Technology Inc that currently offers the largest range of commercially available memory-based FIFO buffers. To add to its 512×9-bit, 1024×9-bit, 2048×9-bit, and 4096×9-bit MK4501 pin-compatible FIFO buffers, the company has recently introduced the 2048×9-bit IDT72103 and 4096×9-bit IDT72104, which

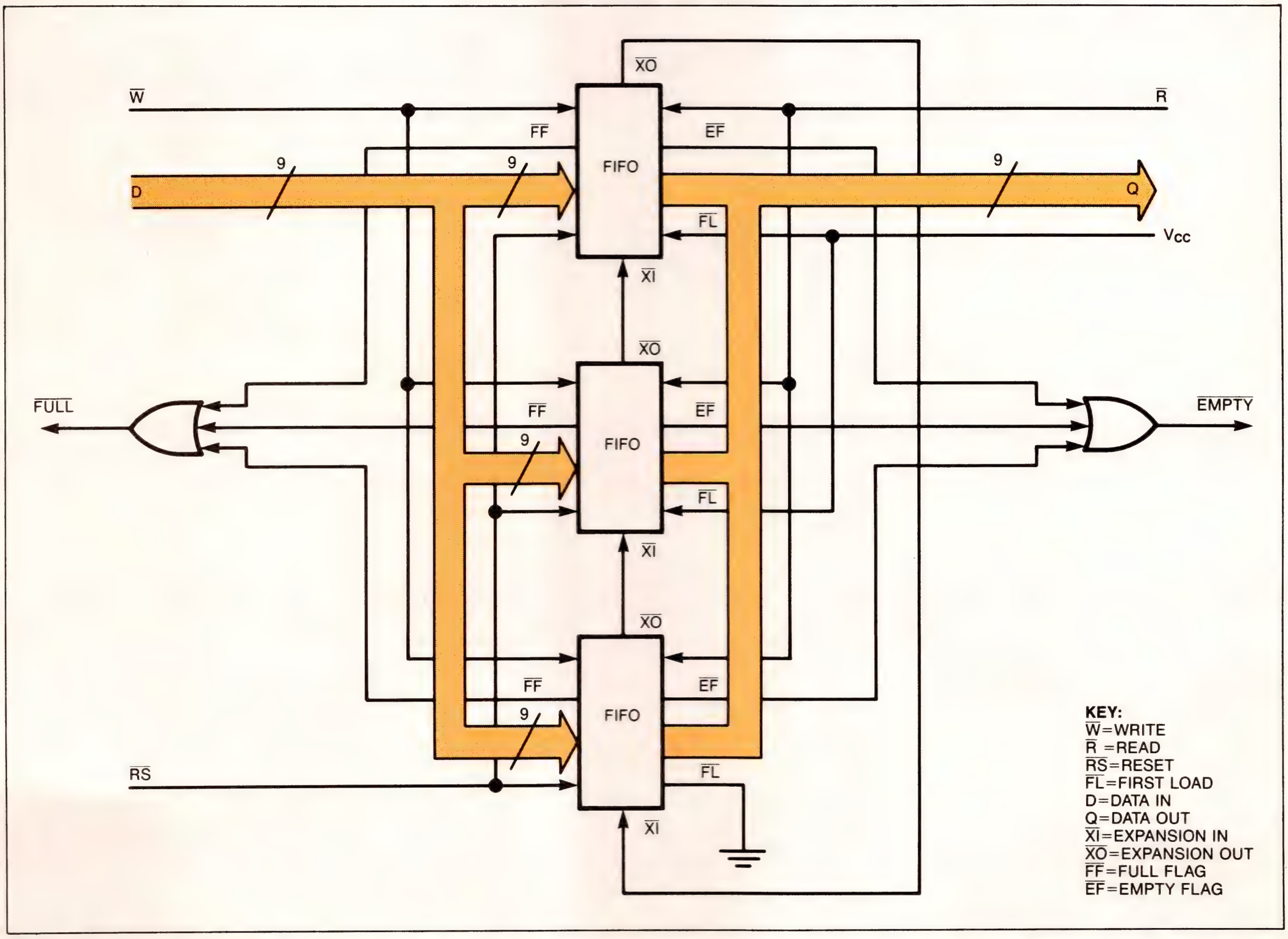


Fig 1—You can expand a FIFO buffer's depth *by using any MK4501-compatible FIFO buffer, irrespective of its capacity, in the above circuit. If your device implements pin 20 as a Half-Full flag output, this output automatically reverts to the expansion-out ($\overline{XO}$) signal when you connect multiple devices.*

feature serial and parallel data inputs and outputs. These FIFO buffers target applications in which the data source or destination is a bit-serial device, such as a magnetic disk drive, a video scan, or a communication link.

The IDT72103 and IDT72104 FIFO buffers incorporate a parallel or serially loaded input register and an output register with parallel and serial outputs. Independent serial/parallel mode controls on the input and output registers allow you to create a serial-to-serial, parallel-to-parallel, serial-to-parallel, or parallel-to-serial FIFO buffer. The part that specs a 65-nsec cycle time lets you load the input or unload the output at serial clock frequencies as high as 40 MHz.

Because serial data is often divided into word lengths other than nine bits, you can program the input register of the IDT72103 and IDT72104 to accept any word length greater than four bits. When you program the FIFO buffer to operate in the serial-input mode, the parallel data inputs become the outputs of an internal, clocked, digital delay line. You program the word length by routing a suitable delay-line output to the write-pulse input of the FIFO buffer. When that delay-line output becomes active, it initiates the parallel transfer of data from the input register to the FIFO buffer's RAM array, and it resets the input register and delay line so they're ready to receive the next serial data word. In addition, the serial-input register has its own expansion logic; you can use multiple devices to expand the word length

TABLE 1—REPRESENTATIVE HIGH-CAPACITY, HIGH-SPEED CMOS FIFO BUFFERS

MANUFACTURER	PART NUMBER	ORGANIZATION (BITS; DEPTH×WIDTH)	MINIMUM READ/WRITE CYCLE TIME (nSEC)	MAXIMUM READ-ACCESS TIME[1] (nSEC)
CYPRESS SEMICONDUCTOR	7C412*	512×9	40, 50, 80	30, 40, 65
	7C424*	1024×9	40, 50, 80	30, 40, 65
	7C429*	2048×9	40, 50, 80	30, 40, 65
DALLAS SEMICONDUCTOR	DS2009*	512×9	65, 80, 100	50, 65, 80
	DS2010*	1024×9	65, 80, 100	50, 65, 80
	DS2011*	2048×9	65, 80, 100	50, 65, 80
INTEGRATED DEVICE TECHNOLOGY	IDT7201	512×9	45, 50, 65, 80, 100, 140	35, 40, 50, 65, 80, 120
	IDT7202	1024×9	45, 50, 65, 80, 100, 140	35, 40, 50, 65, 80, 120
	IDT7201A	512×9	45, 50, 65, 80, 100, 140	35, 40, 50, 65, 80, 120
	IDT7202A	1024×9	45, 50, 65, 80, 100, 140	35, 40, 50, 65, 80, 120
	IDT7203*	2048×9	65, 80, 100, 140	50, 65, 80, 120
	IDT7204*	4096×9	65, 80, 100, 140	50, 65, 80, 120
	IDT72103*	2048×9	65, 80, 100, 140	50, 65, 80, 120
	IDT72104*	4096×9	65, 80, 100, 140	50, 65, 80, 120
MARCONI ELECTRONIC DEVICES	MA7001*	512×9	80, 100	65, 80
MONOLITHIC MEMORIES	67C4500*	256×9	65	50
	67C4501*	512×9	65	50
	67C4502*	1024×9	65	50
PLESSEY SEMICONDUCTORS	MV61901*	1024×9	60	45
	MV61902*	1024×9	60	15
	MV61903*	1024×9	60	15
THOMSON COMPONENTS-MOSTEK	MK4501	512×9	65, 80, 100, 120, 140, 175, 235	50, 65, 80, 100, 120, 150, 200
	MK4503*	2048×9	65, 80, 100, 120, 140, 175, 235	50, 65, 80, 100, 120, 150, 200
	MK4505M*	1024×5	25, 33, 50	15, 20, 25
	MK4505S*	1024×5	25, 33, 50	15, 20, 25
VLSI TECHNOLOGY	VT2KF9*	2048×9	65	50
	VT2KF91*	2048×9	65	50

NOTES: * DATA WAS PRELIMINARY AT THE TIME OF WRITING

1. FOR DEVICES OTHER THAN THE PLESSEY MV61902 AND MV61903 AND THE THOMSON COMPONENTS-MOSTEK MK4505M AND MK4505S, WHICH ARE EDGE-ACTIVATED, THESE FIGURES ALSO REPRESENT THE MINIMUM READ/WRITE PULSE WIDTHS.
2. INCLUDES DEVICES THAT DIFFER IN FIFO-BUFFER DEPTH FROM THE MK4501, AND DEVICES THAT INCORPORATE A HALF-FULL FLAG ON PIN 20 FOR USE IN SINGLE-DEVICE MODE.
3. USE ONLY AS A PRICE GUIDE. PRICE QUOTED IS GENERALLY FOR A LOW-SPEED, COMMERCIAL-GRADE DEVICE.

to greater than nine bits while maintaining the serial word-length programmability. Similar word-length-programmability and expansion facilities exist for the serial output.

The IDT72103 and IDT72104 also feature an impressive array of status flags. In addition to Full, Empty, and Half-Full flags, they have Full−1, Empty+1, Almost-Full, and Almost-Empty flags. The Empty+1 and Full−1 flags indicate that the FIFO buffer has only one filled or one vacant location, respectively. The Almost-Empty and Almost-Full flags are asserted when the FIFO buffer is less than ⅛ full or more than ⅞ full, respectively.

Plessey Semiconductors' MV-61902 and MV61903 FIFO buffers—both of which are organized as 1024×9 bits—are the only FIFO buffers that have user-programmable status flags. In addition to their conventional FIFO-Empty and FIFO-Full flags, these FIFO buffers have a third flag, which the manufacturer has trademarked as the "Dipstick flag."

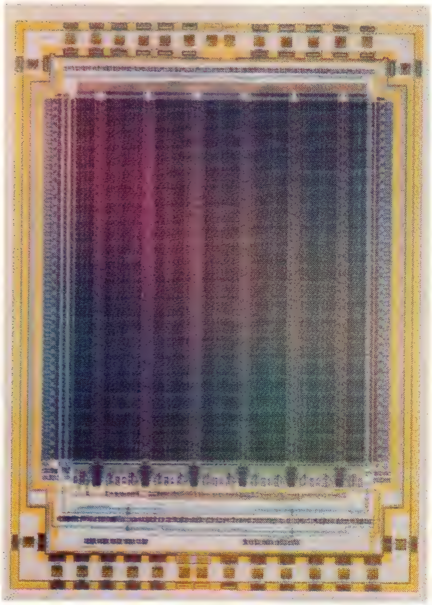
You can program a register within the FIFO buffer so that the Dipstick flag becomes active when a specified number of buffer locations is occupied by data. You specify this number of locations, which can be any number between 0 and 1023, by applying a 10-bit word to the FIFO buffer and by applying a shift-in clock pulse while holding the buffer's master-reset pin active. The nine most significant bits of the 10-bit word are applied to the device's data-input pins, while the least significant bit enters through

FLAGS	MK4501 PIN COMPATIBILITY	PACKAGE (NUMBER OF PINS)	PRICE[3]	REMARKS
E, HF, F	•	DIP (28), LCC (32)	SAMPLES Q2 '87	
E, HF, F	•	DIP (28), LCC (32)	SAMPLES Q2 '87	
E, HF, F	•	DIP (28), LCC (32)	SAMPLES Q2 '87	
E, HF, F	•	DIP (28)	$10.00 (100)	
E, HF, F	•	DIP (28)	$19.50 (100)	
E, HF, F	•	DIP (28)	$42.80 (100)	
E, F	•	DIP (28), PLCC (32), LCC (32)	$13 (100)	
E, F	•	DIP (28), PLCC (32), LCC (32)	$18 (100)	
E, HF, F	•	DIP (28), PLCC (32), LCC (32), TDIP (28), FP (28)	$13 (100)	
E, HF, F	•	DIP (28), PLCC (32), LCC (32), TDIP (28), FP (28)	$18 (100)	
E, HF, F	•	DIP (28), PLCC (32), LCC (32)	$27.00 (100)	
E, HF, F	•	DIP (28), PLCC (32), LCC (32)	$40.50 (100)	
E, E+1, AE, HF, AF, F−1, F		DIP (40), PLCC (44), LCC (44)	$37.00 (100)	DEVICES HAVE BOTH PARALLEL AND SERIAL I/O
E, E+1, AE, HF, AF, F−1, F		DIP (40), PLCC (44), LCC (44)	$55.50 (100)	DEVICES HAVE BOTH PARALLEL AND SERIAL I/O
E, F	•	DIP (28), LCC (28)	£12.74 (1000)	FABRICATED IN CMOS SOS TECHNOLOGY
E, HF, F	•	DIP (28), PLCC (28), LCC (28)	$15.95 (1000)	
E, HF, F	•	DIP (28), PLCC (28), LCC (28)	$18.15 (1000)	
E, HF, F	•	DIP (28), PLCC (28), LCC (28)	$25.40 (1000)	
E, HF, F	•	DIP (28)	£26.92 (1000)	
E, DS, F		DIP (28)	£37.96 (1000)	PROGRAMMABLE DIPSTICK FLAG
E, DS, F, PE		DIP (28)	£41.41 (1000)	PROGRAMMABLE DIPSTICK FLAG AND PARITY LOGIC
E, F	•	DIP (28), PLCC (32), LCC (32)	$13.43 (100)	
E, HF, F	•	DIP (28), PLCC (32)	AVAILABLE Q1 '87	
E, AE, HF, AF, F		TDIP (24)	AVAILABLE Q2 '87	
HF		TDIP (20)	AVAILABLE Q2 '87	
E, HF, F	•	DIP (28), PLCC (32)	$40.34 (1000)	
E, AE, AF, F		PLCC (32)	$41.50 (1000)	

KEY: AE=ALMOST EMPTY
AF=ALMOST FULL
DS=PROGRAMMABLE DIPSTICK FLAG
E=EMPTY
F=FULL
HF=HALF FULL
PE=PARITY ERROR
DIP=600-MIL DUAL-IN-LINE PACKAGE
FP=FLAT PACK
LCC=LEADLESS CHIP CARRIER
PLCC=PLASTIC LEADED CHIP CARRIER
TDIP=300-MIL DUAL-IN-LINE PACKAGE

the FIFO buffer's output-ready pin.

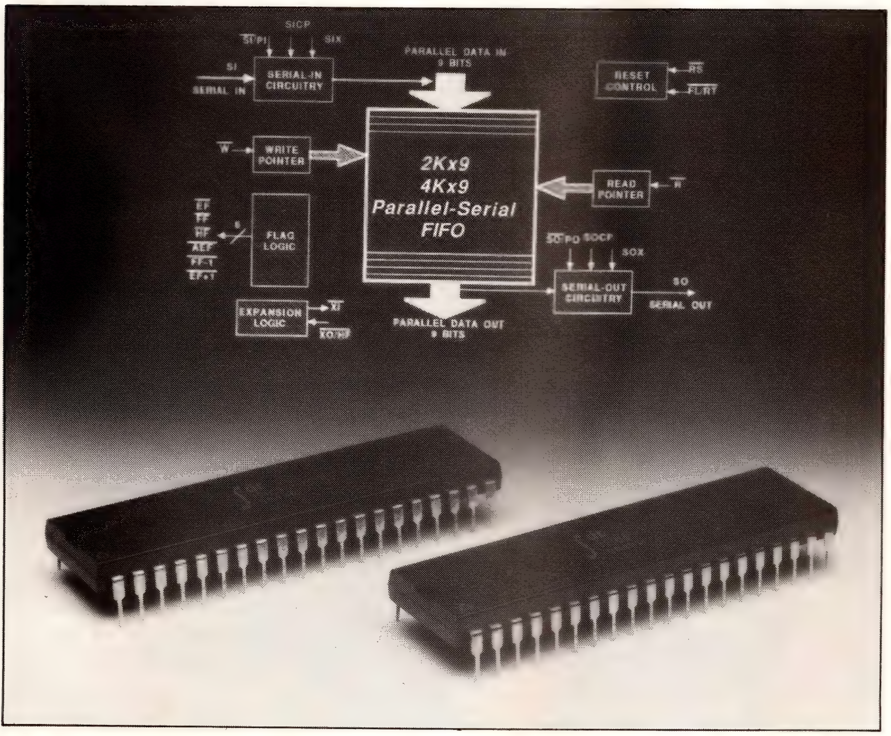
Because the output-ready pin normally functions as an output, when you're programming the Dipstick-flag value you'll have to drive the output-ready pin from 3-state logic or from a 0 to 5V logic source with a source impedance of 10 kΩ or more.



This micrograph of a 2k×9-bit FIFO buffer, *VLSI Technology's VT2KF9, illustrates the regular array of memory cells typical of memory-based CMOS FIFO buffers.*

The dipstick value remains intact during subsequent reset periods, provided you don't issue a further shift-in pulse during these resets. If you don't program the dipstick value at all, it remains at its power-up value, which sets the dipstick function to act as a Half-Full flag.

In addition to offering the Dipstick function, the MV61903 FIFO buffer incorporates parity checking/generation logic. You can program the parity logic to check the even or odd parity of the eight least significant input bits against the ninth input bit; parity errors are indicated on a separate parity-error flag output. Alternatively, you can program the parity logic to generate an even or odd parity bit from the eight least significant input bits (after they have passed through the FIFO buffer); this bit is then substituted for the ninth bit in the output data. You program the parity logic during master-reset periods at the same time that you program the Dipstick flag, by using the parity-error and Dipstick-flag outputs as inputs into which you place a 2-bit code. This 2-bit code allows you to enable or disable parity generation and to select even or odd parity generation/checking. As with the output-ready pin, you'll have to drive the parity-error pin and Dipstick-flag pin from 3-state logic or from a 0 to 5V logic source with a source impedance of 10 kΩ or more.



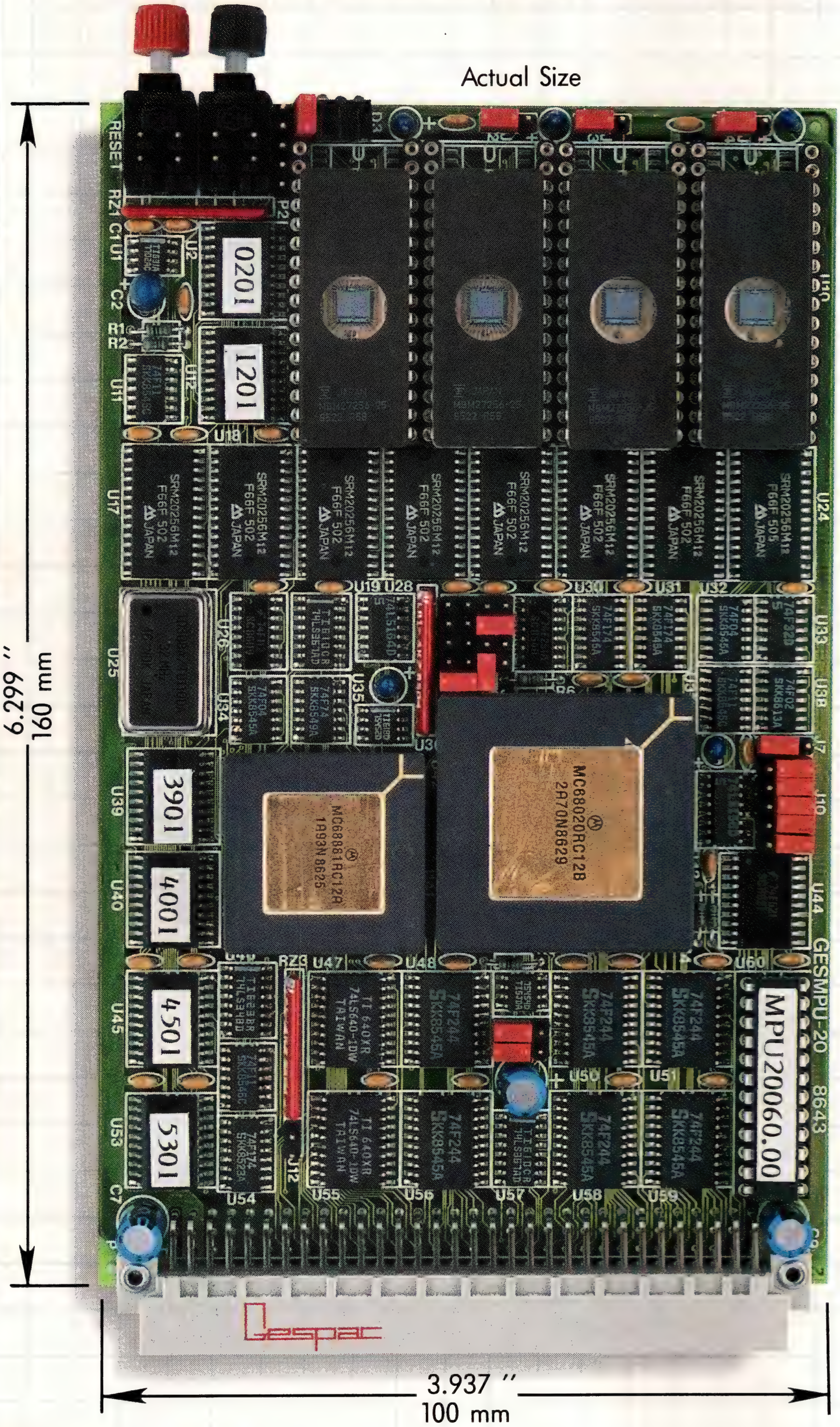
Featuring parallel and serial I/O ports, *the 2k×9-bit IDT72103 and 4k×9-bit IDT72104 FIFO buffers from Integrated Device Technology provide data-rate buffering for serial devices such as disk drives. In addition, each device sports seven status flags that indicate the amount of data in the FIFO buffer.*

The MV61902 and MV61903 aren't pin compatible with the MK4501. Because their input and output handshaking controls are different from those of the other FIFO buffers listed in **Table 1,** and because they each have an independent, 3-state, output-enable control line, their 28-pin package is short on pins. As a result, the MV61902 has only two outputs with which to indicate the FIFO-Full, FIFO-Empty, and Dipstick flags, and the MV61903 has room for only one capacity-flag output, which it uses to indicate the state of the Dipstick flag.

The MV61902 must, therefore, encode three flag conditions on its two flag-output lines. As a result, you'll need a few spare 2-input gates and inverters or a 2- to 4-line decoder chip to decode the two flag-output lines into single-line flag outputs. Similarly, with the MV61903 you'll require a couple of D-type flip-flops to decode the FIFO-Empty and FIFO-Full conditions from the input and output handshaking lines.

In some applications, however, the Dipstick flag can save you external logic. For example, if you want to delay data by a programmable number of clock periods—a common requirement in DSP applications—all you need to do is to AND the dipstick-flag output with the shift-in clock and connect the AND-gate output to the shift-out clock. When you start to clock the FIFO buffer, data will be placed in the FIFO buffer, but the AND-gate output

GESPAC Gives You More Power Per Square Inch.



Here is the size, performance, and cost breakthrough you have been waiting for: The 68020 based GESMPU-20 from GESPAC.

You can now unleash an unprecedented amount of power into your applications. On just 25 square inches, we have squeezed a 12.5 MHz (16 MHz optional) 68020 32-bit microprocessor, a 68881 floating point coprocessor, 4 sockets for up to 512 Kilobytes of EPROM, and up to 512 Kilobytes of zero-wait-states CMOS RAM.

This board is totally expandable through its G-64 bus interface. And GESPAC has the largest variety of inexpensive memory, interfaces, controllers, and transducer cards anywhere. Plus real-time disk operating systems, high level languages, and other software tools. GESPAC has the total solution to your system integration needs.

Best of all, because our boards are small, they cost less. The new GESMPU-20 is priced below $1000 in one hundred piece quantity orders.

So why wait? Contact us today for information on the GESMPU-20 or any of the 150 G-64 bus system components from GESPAC—the leader in single Eurocard microcomputer products worldwide.

Call (602) 962-5559.

IN USA - CANADA
50A West Hoover Ave.
Mesa, Arizona 85202
Tel. (602) 962-5559
Telex 386575

INTERNATIONAL
3, chemin des Aulx
CH-1228 Geneva
Tel. (022) 713400
Telex 429989

CIRCLE NO 67

won't start to clock data out until the Dipstick flag becomes active. Because you can program the Dipstick to any value between 0 and 1023, you have full control over the input-to-output delay.

Although they don't have the fastest read/write cycle time, the MV61902 and MV61903 do possess the fastest read-access time (15 nsec) of any of the 9-bit FIFO buffers listed in **Table 1.** Further, the MV61902 and MV61903 each have a separate 3-state output control. Using these features, you can double a FIFO-buffer system's data rate by multiplexing data between two devices as shown in **Fig 2.**

The MV61902 and MV61903 FIFO buffers also feature a 0-nsec data-hold time relative to the active edge of the shift-in pulse. This spec could save you a 9-bit latch if you're interfacing to systems that don't guarantee they will hold data after the active clock edge.

Note that the unique features of the MV61902 and MV61903 are the Dipstick flag and parity logic. You could implement some applications that use these features—for example, the programmable digital delay line—by adding external logic to other, less-expensive FIFO buffers. Unless you're constrained by other factors, such as pc-board space or power-supply considerations, therefore, you should weigh the higher cost of the MV61902 and MV61903 against the cost of the external logic that you'd have to add to other FIFO buffers to achieve the same functionality.

Thomson Components-Mostek Corp should soon be able to lay claim to the fastest high-capacity, memory-based FIFO buffer around. One speed selection of its 1024×5-bit MK4505 FIFO buffer, which is currently under development, specs a read/write cycle time of 25 nsec, which allows the input and output of parallel data at clock frequencies as high as 40 MHz. The device has independent input and output clocks. It's designed for use in systems (such as digitized video or

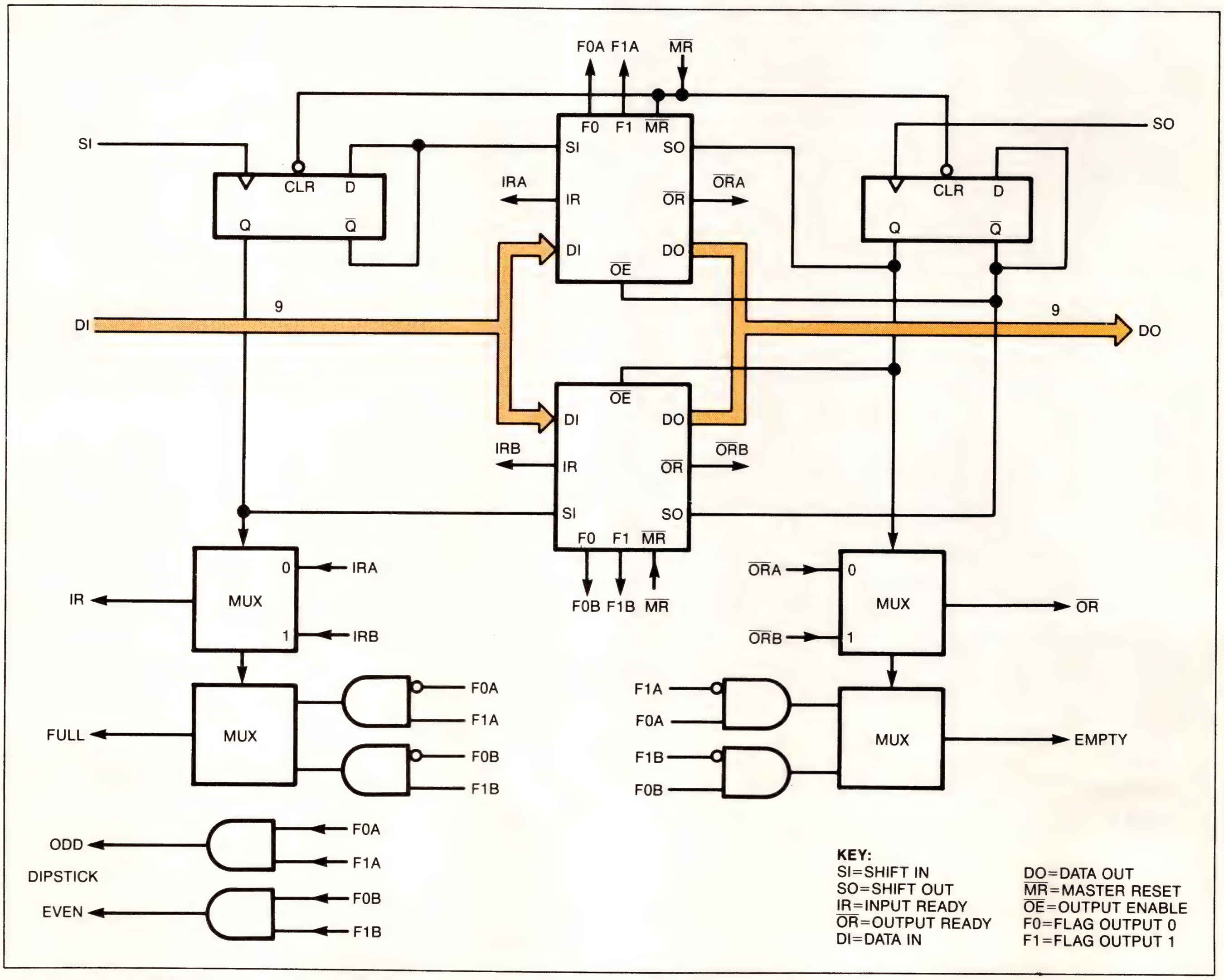


Fig 2—To double the speed of your FIFO-buffer system, *you can take advantage of the 15-nsec read-access time of Plessey Semiconductors' MV61902 by using this circuit, which multiplexes data between two FIFO buffers. Although you could apply this technique to other manufacturers' FIFO buffers, you'd require more complex external logic to do so.*

Superior performance now runs in the family.

Introducing the 8842A digital multimeter.

Choices. Choices.

Should you choose the powerful Fluke 8840A? Or the new, advanced 8842A?

Depending on the level of performance you need, consider this:

Enhanced capabilities for new applications.

The new 8842A is so technologically superior, it can outperform DMMs costing twice as much. Its capabilities include 0.003% 1-year basic accuracy and 100 nV resolution for dc voltage measurements. And it incorporates exclusive new thin film resistors* for a two-year calibration cycle.

The widely-accepted 8840A on the other hand, offers value unmatched by any other DMM in its class. Like the 8842A, it's simple to operate. It gives you long-term reliability. And it delivers high productivity with a low overall cost of ownership.

Choose either model for under $1,000.

The 8840A starts at $795, the 8842A at $995. Both are also available with True RMS AC and IEEE-488 capabilities. Which one is right for you? The choice may not be easy. But at least now, it's a family decision.

Call toll-free 1-800-44-FLUKE (1-800-443-5853) Ask for extension 140.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 8840A		FLUKE 8842A	
0.005% basic dc accuracy (1 Yr.)		0.003% basic dc accuracy (1 Yr.)	
0.16% basic ac accuracy (1 Yr.)		0.08% basic ac accuracy (1 Yr.)	
0.013% basic ohms accuracy (1 Yr.)		0.008% basic ohms accuracy (1 Yr.)	
Resolution to 1μV dc, 10μA dc, 1mΩ		Resolution to 100nV dc, 1μA dc, 100μΩ	
One-year specifications and warranty		Two-year specifications and warranty	
8840A	$795	8842A	$995
8840A-09 with AC True RMS	$990	8842A-09 with AC True RMS	$1,245
8840A-05K IEEE-488 Field Kit	$170	8842A-05K IEEE-488 Field Kit	$170

FLUKE®

* Patent pending

IN THE U.S. AND NON-EUROPEAN COUNTRIES: John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206, Sales: (206) 356-5400, Other: (206) 347-6100.
EUROPEAN HEADQUARTERS: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven, The Netherlands, (040) 458045, TLX: 51846.
© Copyright 1985 John Fluke Mfg. Co., Inc. All rights reserved. Ad No. 2801-8842

CIRCLE NO 68

audio, image processing, or continuous A/D- or D/A-conversion systems) through which data moves continuously on a square-wave clock.

The MK4505 will be available as either a 24-pin master device (MK4505M) or a 20-pin slave device (MK4505S) in the second quarter of 1987. The master device provides all the control signals necessary to expand a FIFO buffer's width and depth, and it also includes Empty, Almost-Empty, Half-Full, Almost-Full, and Full flags, as well as Input-Ready and Output-Valid handshaking pins.

The slave device has only a Half-Full flag, but it has a second write-enable input, and it includes an additional read-enable input that acts as a 3-state output control. Unlike the master device, the slave device can be forced to write data to and read data from the RAM array irrespective of the FIFO buffer's Full or Empty status. In other words, when the FIFO buffer is full, you can overwrite its contents. When the FIFO buffer's status is set at Empty (after you've read the last word out of it), you can make it reread the entire contents of the FIFO buffer. Note that the ability to reread the entire contents of the FIFO buffer differs from the retransmit facility on MK4501-compatible devices; that facility resets the memory array's Out pointer to location 0. This feature allows you to implement such functions as data-tracing (continuous write) or message-retry (continuous read) operations. **EDN**

Article Interest Quotient
(Circle One)
High 503 Medium 504 Low 505

For more information . . .

For more information on the FIFO buffers described in this article, circle the appropriate number on the Information Retrieval Service card or contact the following manufacturers directly.

Cypress Semiconductor Corp
3901 N First St
San Jose, CA 95134
(408) 943-2600
Circle No 705

Dallas Semiconductor Corp
4350 Beltwood Parkway
Dallas, TX 75244
(214) 450-0400
Circle No 706

Integrated Device Technology Inc
3236 Scott Blvd
Santa Clara, CA 95054
(408) 727-6116
Circle No 707

Marconi Electronic Devices Inc
80 Smith St
East Farmingdale, NY 11735
(516) 756-1900
Circle No 708

Marconi Electronic Devices Ltd
Lincoln Industrial Park
Doddington Rd
Lincoln LN6 3LF, UK
(0522) 688121
Circle No 709

Monolithic Memories Inc
2175 Mission College Blvd
Santa Clara, CA 95050
(408) 970-9700
Circle No 710

Plessey Semiconductors
3 Whatney
Irvine, CA 92718
(714) 951-5212
Circle No 711

Plessey Semiconductors Ltd
Cheney Manor
Swindon
Wiltshire SN2 2QW, UK
(0793) 36251
Circle No 712

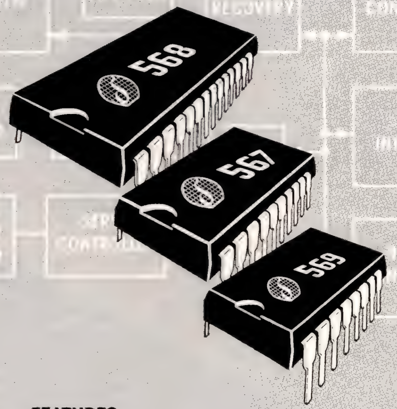
Thomson Components-Mostek Corp
1310 Electronics Dr
Carrollton, TX 75006
(214) 466-6000
Circle No 713

Thomson Semiconducteurs
45 Ave de l'Europe
78140 Velizy, France
(1) 39469719
Circle No 714

VLSI Technology Inc
1101 McKay Dr
San Jose, CA 95131
(408) 434-3000
Circle No 715

SPOTLIGHT #25
IN A SERIES

NEW
SERVO CHIP SET FOR
HIGH PERFORMANCE
HARD DISK DRIVES



FEATURES:

SSI 567 SERVO DEMODULATOR
- Servo demodulation for dedicated surface servo systems
- Di-bit quadrature servo pattern
- PLL synchronization

SSI 568 SERVO CONTROLLER
- Servo control for dedicated surface servo systems
- Quadrature servo pattern
- Linear velocity control loop
- Programmable offset and gain control
- Microprocessor bus compatible interface

SSI 569 SERVO MOTOR DRIVER
- Voice coil servo motor predriver
- Compatible with complementary power FETS
- Bridge output driver configuration
- Automatic head retract and spindle motor brake command in the event of power supply failure

Now, with Silicon Systems new Servo Chip Set, HDD designers have the means to provide fast, precise, head positioning in their high performance hard disk drives.

The new chip set provides superior performance and features lower power dissipation, reduced board space, and lower cost than alternative design approaches. With its high level of integration, the set includes all the functional building blocks needed in the servo channel, and it is easily controlled via the microprocessor interface.

For more information, contact:
Silicon Systems, 14351 Myford Road,
Tustin, CA 92680.
Phone: **(714) 731-7110, Ext. 575.**

silicon systems
INNOVATORS IN INTEGRATION

CIRCLE NO 18

SILICON SYSTEMS– INNOVATORS IN INTEGRATION

Demonstrated Leadership in Combining Analog and Digital Designs on a Single Chip, and Offering Both CMOS and Bipolar Processing in Our Own Advanced Wafer Fab.

Gary Kelson
Senior Vice President, Chief Technical Officer

DESIGN EXPERTISE

Silicon Systems is years ahead of the competition in the design of custom and semicustom analog, digital, and combined analog/digital IC's in Bipolar and CMOS technologies. One reason for this success is our heavy investments in the most advanced computer-aided design system called IDM— Integrated Design Methodology. This proprietary design tool is the ultimate solution for supporting our customers' requirements. IDM allows auto-routed cells, compiled macros, and full custom circuitry to be intermixed on a single chip. The result: IDM provides faster turnaround, lower cost, and higher performance while eliminating design errors.

This design "edge" has led us into a broad diversity of design applications. However, we aren't resting on our laurels. With a dedicated design automation team with 14 years of experience, we are defining the state-of-the-art for future analog and analog/digital design methodologies. Furthermore, our systems engineering background allows Silicon Systems to live up to its name by providing true systems on a chip performance, thereby affording our customers a true competitive advantage.

PROCESS EXPERTISE

But there's more to a great IC company than just great design. And that's why Silicon Systems developed a multiprocess wafer fab running advanced CMOS and Bipolar technologies optimized for ASIC development and production.

We run 3μ CMOS with both high voltage (12V) and low voltage (5V) analog/digital options. We also run 2μ CMOS for digital applications and will soon be scaling these to 1.25μ CMOS with analog enhancements to follow.

In Bipolar, the company has extensive experience producing analog/digital design with our 3μ, 4GHz f_T process. We are ramping up our newest Bipolar technology which will extend our processes to 6 GHz f_T and even lower noise capability.

The point is: there is no company better equipped to provide the right custom/semicustom chip solutions for your most challenging analog, digital, or combination analog/digital design problems. So, if you'd like to give your product a competitive edge, call or write for more information: Silicon Systems, 14351 Myford Road, Tustin, CA 92680. Phone: (714) 731-7110.

Circle 45 for career information

silicon systems™
INNOVATORS IN INTEGRATION

Circle 6 for product information

YOU'RE ON
AS YOUR

When you're trying to build the hottest new products you can think of, you need the latest, most sophisticated ASICs available. And the greatest number of ways to use them.

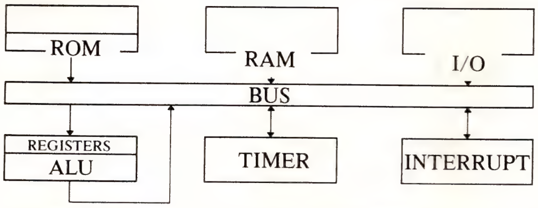
And that's the whole idea behind our Triple Technology.™ Which gives you the ability to combine analog, digital, and E² cells all on the same chip. And the confidence that they all fit

JANUARY

8 BIT Microcontroller Core Processor

Key Features

Core size:	4620 Sq. mils
Technology:	2μ CMOS
Speed:	20 MHz Clock
Low Voltage:	3 Volts
Low Power:	<1 mA Static Halt Mode



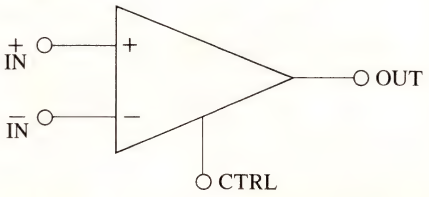
100% compatible with National's COP820C 8-bit microcontroller, this core processor features modifications on its pinout to make it more flexible. Because of its small size and versatile architecture, it can be combined — on a single chip — with digital, analog, EEPROM and peripheral megacells from our library, such as keyboard encoder, UART, RTC, LCD/LED driver, and Watch Dog timer. The net result is a dramatic savings in part cost and board area.

FEBRUARY

RS422 Differential Line Receivers And Drivers

Key Features

Differential Input Pulse Width	20 ns (min)
Output Pulse Width	12 ns (min)
Internal Hysteresis	150 mV (typ)
Output Drive Current @ Vol = 0.5V	48 mA (min)
Operating Range	4.5 to 5.5 Volts 0 to 70° C
Technology	2μ CMOS



Designed for high-speed data transmission in a noisy environment, this new cell lets you integrate analog interface circuitry with digital design. It can be simulated, along with digital circuitry. It's fully compatible with our 280 digital cells, 30 analog cells, and 20 EEPROM cells. It also gives you 2 micron technology. In CMOS. So you can look for reduced board space, and low power consumption.

LY AS GOOD
LAST IDEA.

together, since they've all come from the same source. Of course, we already give you the richest cell library in the industry. But every month this year, we'll use this space to introduce our latest ideas. To give you more possibilities than ever. If you'd like to see our complete library card, just write or call. In the meantime, just look what we've done for you lately.

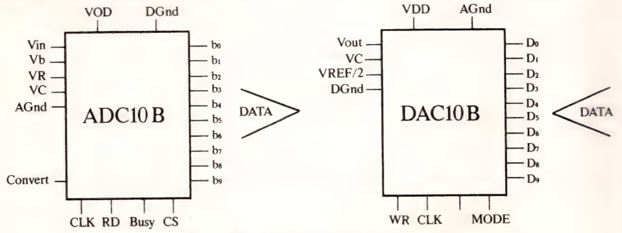
MARCH

ADC10B 10-BIT A/D Converter

Key Features (Both cells)

Accuracy	10-bit
Power consumption	5V ± 10%
Technology	2μ CMOS

A low-power, 10-bit successive approximation differential input converter which uses a combination of ratioed resistors and ratioed capacitors.



DAC10B 10-BIT D/A Converter

A 10-bit ratioed capacitor and resistor string DAC with a deglitched sampled-and-held buffered output. Like the ADC10, it also uses 2 micron technology. In CMOS. All of which makes us a tough act to follow. And gives you a good reason to watch this space in April.

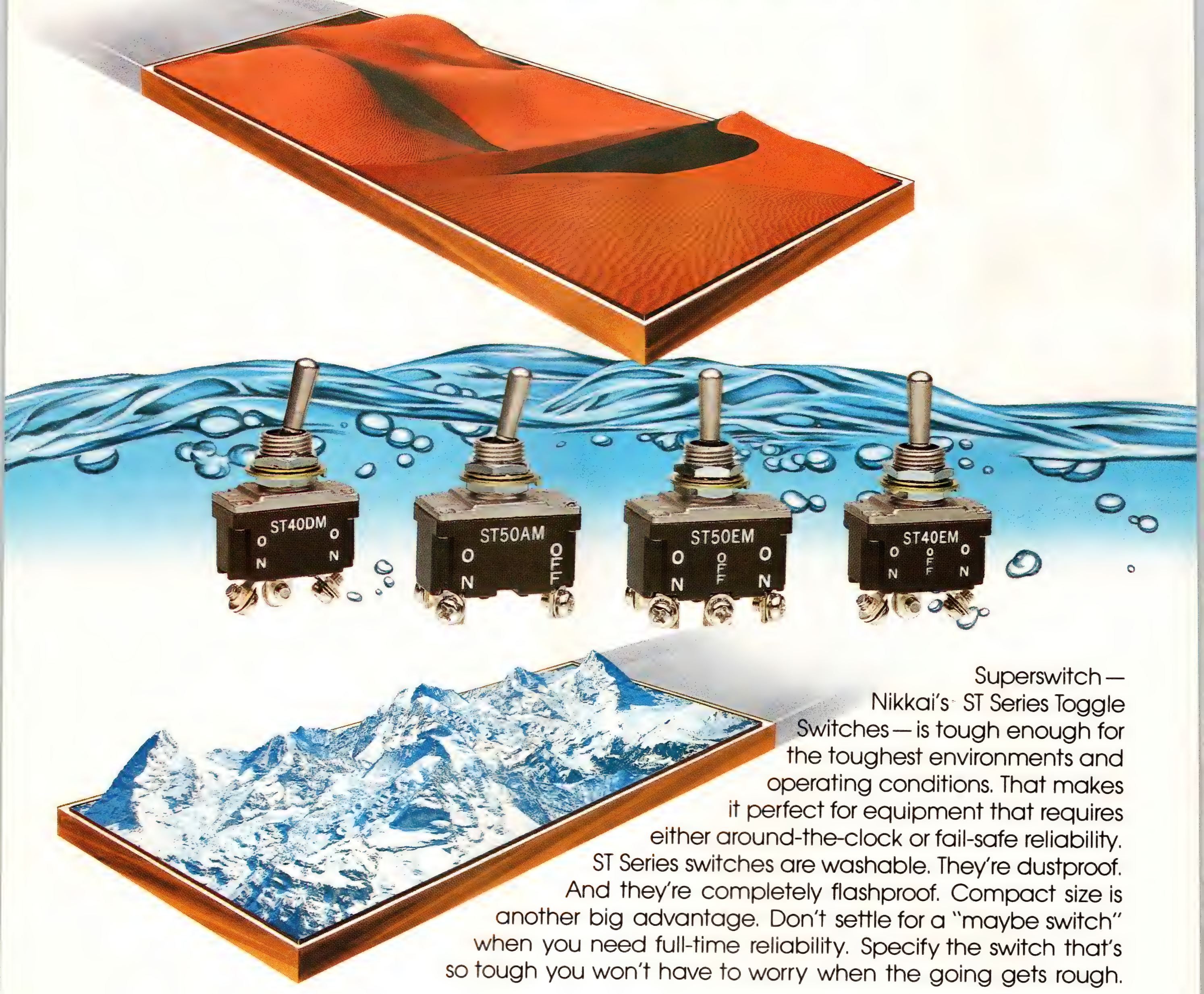
APRIL

Sierra Semiconductor
Triple Technology.™ In CMOS.

2075 N. Capitol Ave., San Jose, CA 95132 (408) 263-9300

CIRCLE NO 69

NOTHING CAN STOP A SUPERSWITCH FROM PACKING PERFORMANCE INTO YOUR PRODUCTS.



Superswitch—Nikkai's ST Series Toggle Switches—is tough enough for the toughest environments and operating conditions. That makes it perfect for equipment that requires either around-the-clock or fail-safe reliability. ST Series switches are washable. They're dustproof. And they're completely flashproof. Compact size is another big advantage. Don't settle for a "maybe switch" when you need full-time reliability. Specify the switch that's so tough you won't have to worry when the going gets rough.

** For more information, please write to:*

NKK nikkai

NIHON KAIHEIKI IND. CO., LTD.
Tokyo, Japan Phone: (03) 774-0611
Telex: 0246-6949 NIKKAI J

Australia	STC-Cannon Components (PTY.) Ltd. Phone: (03) 555-1566 Telex: AA30877
Belgium	Sotronic S.A./N.V. Phone: 02/736 10 07 Telex: 25141 Sonic B
Denmark	Tage Olsen A/S. Phone: 2/65 81 11 Telex: 35293 Toas DK.
Finland	Perel Oy. Phone: 914-21600 Telex: 15117 Perel SF.
France	Ste. Comepa S.a.r.l. Phone: 4844-87-39 Telex: 670937, 670937F
Germany	Marquardt GmbH. Phone: (07424) 707-0 Telex: 760412 MARQ D
Great Britain	Lucas NSF Limited. Phone: (0535) 661144 Telex: 51270 Enesef G.
India	Bells Controls Limited Phone: (Mysore) 26772 Telex: 846255
Italy	KEVIN S.R.L. Phone: (2) 45 31 196 Telex: 325239 KEVIN I
Korea	Bosung Hwarim Co., Ltd. Phone: 722-3449 Telex: K22340 HWARIM.
Netherlands	Nijkerk Electronika B.V. Phone: 020-5495969 Telex: 11625 NESCO NL
Norway	Elektronix A/S Phone: (02) 559050 Telex: 72738 Elnix N
Sweden	Stigab/stig Odlung AB Phone: 08/97 09 90 Telex: 12496 Stigab S
Switzerland	Invertag Limited Phone: 01/391 56 30 Telex: 816906 Invag Ch
Taiwan	Magna Corporation Phone: 02-561-0851 Fax: (02) 542-0404
North America	NKK Switches of America INC. Phone: (602) 991-0942 TWX: 910-950-1167 'NKK SCOT'.

CIRCLE NO 55

In Power

64-BIT
SPEED

Well, not quite!
But we are that far
ahead in power
conversion technology.

Our power
converters and
boosters offer
the small size,
reliability and high
switching speeds
that make
today's products
work, and
tomorrow's
designs possible.

We can supply
the power for a
wide range of
applications,
to keep you ahead
of your rivals.

To find out more,
contact:

In Power
Ballysimon Road
Limerick Ireland
Tel: International
+353 61 49677
Fax: (G3)+353 61 42730
Tlx: 70322 IPKO EI

TEN NEW RS-232 SOLUTIONS.

Pick a +5V-powered single-chip transmitter/receiver for your application.

Typical App.	Part No.	Number XMTRS	Number RCVRS	Shutdown Three-state	On-board Caps.	Number Pins	Price (100up)
Digital PBX Interface	MAX230	5	0	Yes	No	20	$ 4.00
Peripheral Interface	MAX231*	2	2	No	No	14	2.52
General Purpose Interface	MAX232	2	2	No	No	16	3.60
Gen. Pur. Interface/ Space Saver	MAX233	2	2	No	Yes	20	6.75
+5V 1488 Replacement	MAX234	4	0	No	No	16	3.60
Synchronous Communications	MAX235	5	5	Yes	Yes	24	10.00
Battery Powered Equipment	MAX236	4	3	Yes	No	24	5.00
Modem Interface	MAX237	5	3	No	No	24	5.00
+5V 1488/1489 Replacement	MAX238	4	4	No	No	24	5.00
IBM® PC Compatible	MAX239*	3	5	Yes	No	24	5.00

*+5V and +12V powered. All others are powered by +5V only.

If you're looking for single-chip +5V RS-232 transmitters/receivers, you've come to the right place.

Maxim offers you more RS-232 choices than anybody else. Not to mention some very special features. Like low-power shutdown. And space-saving onboard capacitors.

What's more, you get Maxim's renowned quality. Like free 24-hour/150°C burn-in of every part. And a failure rate of seven parts per billion hours of operation (by far the best in the industry).

So now that you've found what you're looking for, simply call your Maxim representative or distributor for samples and data sheets.

Maxim Integrated Products, 510 N. Pastoria Avenue, Sunnyvale, CA 94086, (408) 737-7600.

MAXIM

Distributed by Hall-Mark, Pioneer, Graham, Diplomat and Bell. Authorized Maxim Representatives: Alabama, (205) 536-3044; Arizona, (602) 860-2702; California, (408) 727-8753, (619) 279-0420, (714) 739-8891; Colorado, (303) 841-8440; Connecticut, (203) 269-7964; Florida, (305) 365-3283; Georgia, (404) 448-1215; Idaho, (503) 620-1931; Illinois, (312) 956-8240; Indiana, (317) 849-4260; Iowa, (319) 377-8275; Kansas, (316) 838-0884; Maryland, (301) 583-1360; Massachusetts, (617) 444-8071; Michigan, (313) 499-0188; Minnesota, (612) 941-7181; Missouri, (314) 291-4777, (816) 356-6340; Montana, (503) 620-1931; New Hampshire, (603) 772-3300; New Jersey, (609) 933-2600; New Mexico, (505) 884-2256; New York, (516) 543-0510, (716) 385-7744; North Carolina, (919) 847-8800; Ohio, (216) 659-9224, (513) 278-0714, (614) 895-1477; Oklahoma, (918) 832-7747; Oregon, (503) 620-1931; South Carolina, (803) 233-4367/8; Texas, (214) 386-4888, (512) 451-2757, (713) 778-0392; Utah, (801) 266-9939; Washington, (206) 453-8881; Wisconsin, (414) 476-2790. Canada, (416) 238-0366, (604) 464-7620, (613) 762-9562.

United Kingdom, Maxim UK Ltd., 0735-75255, Dialogue Distribution, Ltd., 0276-682001, Thame Components, Ltd., 084-421-4561.

Maxim is a registered trademark of Maxim Integrated Products. IBM is a registered trademark of International Business Machines Corp. © 1986 Maxim Integrated Products.

CIRCLE NO 70

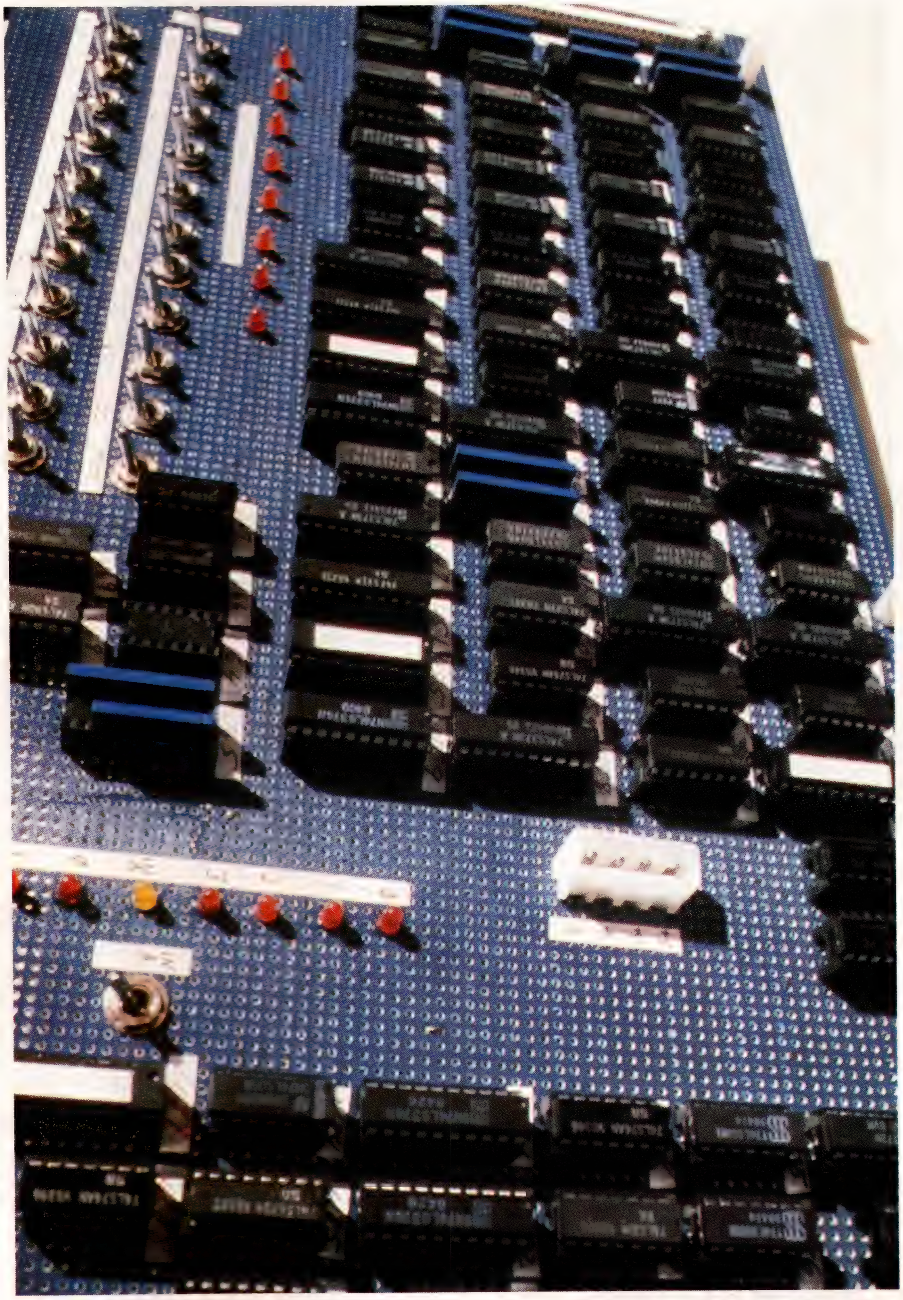
Tools help you retain the advantages of using breadboards in gate-array design

David Shear, *Regional Editor*

When you've considered the various approaches to developing a gate array, you may have deemed the use of a breadboard as impractical. Simulation has promised to make breadboards obsolete, and the effort to create the breadboard sometimes seems prohibitive. Now, however, with careful selection of device types and helpful design tools, you can reap the benefits that creating a breadboard still confers, whether you intend to build a gate-array design right away, or to convert from a design initially based on programmable devices to gate-array form at a later date. In the near future, you may be able to retain these benefits through the use of emulators that allow a thorough verification and simplify the process of modification.

The use of a breadboard enhances, rather than replaces, simulation, which remains an essential part of the design process. Simulation ensures that the gate array will perform the defined task properly, provided that the task is properly defined. Worst-case analysis and verification of critical timing paths require the use of simulation.

Simulation, however, has limitations of its own. It cannot yet thoroughly verify a design at the system level. This activity is still the domain of the engineer, and all engineers can make mistakes. What's more, simulation only answers what's asked of it, and it can only test a portion of a design. If you don't direct the simulation to look at the circuitry that contains an error, or that is malfunctioning because of an error elsewhere in the design, that error will go undetected. Also, the time required to test an entire design with a simulator is prohibitive, even with the accelerators now on the market. Finally, the simulation of multiple-feedback shift registers, such as pseudorandom binary sequencers and error-correction circuitry, is beyond the limits of to-



Because of schedule constraints, *the gate array in Data I/O's Unisite 40 universal programmer had to work the first time. Company engineers built this breadboard to prove the design of a gate array.*

Our simulations are accelerated on the MAGNUM. It's fast, low-cost and it's a Zycad.

The New Magnum from $38,000

Zycad introduces a low-cost, high-performance family of simulation accelerators for project teams designing ASICs or entire systems. Now everyone on the team – and every project team – can afford to accelerate logic and fault simulation, right from their desks.

Fast and Flexible

Magnum Integrates easily into your existing simulation environment with a wide variety of interfaces to industry-standard simulators and hardware platforms. A Magnum on the team will turn simulation hours into minutes.

Available Options

- Hardware fault simulation
- Bidirectional switches
- ZILOS™ software package
- Memory modeling expansion

Choose from Four Models

Pick a Magnum that's right for your specific project. Zycad offers you four Magnum models that are totally compatible with our Expeditor,™ Logic and Fault Evaluator® and System Development Engine™ families. Zycad gives you the widest range in accelerator capacity and capability.

Simulation Experts

Zycad application engineers match the performance level of our accelerators in terms of customer support. Your team can count on us for on-site training, toll-free hotline help and simulation tips on how to maximize your accelerator's performance.

Put Magnum on your team. Call or write: Zycad, 3500 Zycad Drive, St. Paul, MN 55109. 1-800-631-5040 (in Minnesota, 612-779-5555).

zycad

©1986, Zycad Corporation.

CIRCLE NO 71

day's computing power.

Some of the classic reasons for building a breadboard still apply, but there are also some very important benefits that did not exist in the past. The best known advantage to using a breadboard is the ability to test the design in the system and debug the logic in real time. If the board-level system that will incorporate your design must work with the unpredictable timing of asynchronous events, you can monitor its reaction to these stimuli. Another familiar advantage is the ability to test any existing software to ensure that the new design is compatible with a previous design.

When problems occur, you have access to all of the circuitry. Simple modifications take a very short time to effect, and then you can test the design again. Even if you must make major architectural changes, you can still use much of the breadboard.

A little known—but important—advantage to using a breadboard involves the generation of test vectors. The creation of test vectors is a time-consuming and tedious task, and it's very easy to make a simple error when you're dealing with ones and zeros. Yet without an accurate and comprehensive list of test vectors, it's difficult to verify the design with a simulator and test the resulting silicon samples from the first production run.

With the help of a logic analyzer and a word processor, you can use your breadboard to create your test vectors. The logic analyzer connects to the breadboard at the same places where the pins of the final gate array will be. As the system runs, the logic analyzer captures all of the generated patterns. You can then edit these test vectors with the word processor and render them into a form acceptable to the gate-array manufacturer. In effect, the system automatically, and accurately, creates the test vectors.

On a typical project you can't test the software until the hardware has been verified. If you don't build a breadboard, the software engineers will have to wait until the gate-array prototypes have returned from the foundry and have been tested in the system before they can exercise the software. If you do use a breadboard, the software engineers can begin their tests as soon as the breadboard is verified—significantly shortening the design-to-production schedule as a result. Obviously, test engineers also have access to the working system much sooner when you use a breadboard. You can even build more than one breadboard, so that all those needing the working system have simultaneous access to it.

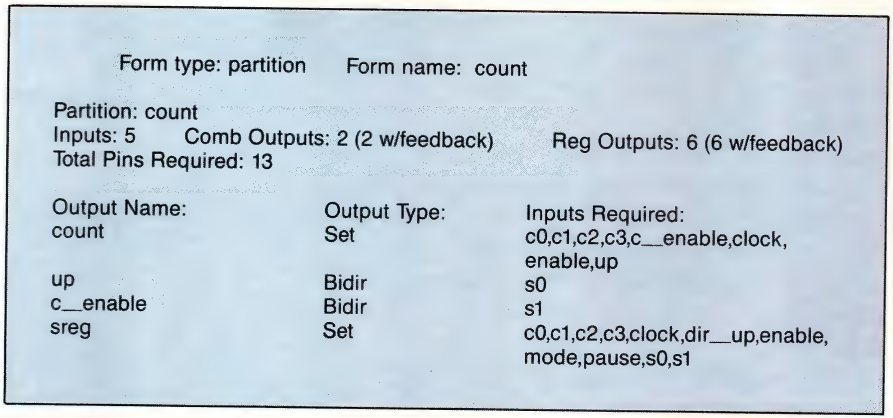
***You can quickly test and modify a design** in an actual circuit, in real time, using Xilinx's XC-DS24 Xactor in-circuit emulator.*

You might also consider giving a system based on the breadboard to select customers for beta-site testing. Even though the system may not match the size or the speed of the production version of your design, you can derive valuable information by analyzing the response of the end user.

A breadboard will help streamline the process of iteration as well—a process whose importance is too frequently underestimated. Quite often management, the design community, and even engineers themselves expect to create a virtually perfect design at the start, but the reality couldn't be more different. A good design counts on the engineer's having an opportunity to test and optimize it repeatedly; a breadboard readily provides that opportunity.

The creation of a large breadboard is not an easy task. You should automate as much of the process as possible to minimize the possibility of human error. The use of PLDs or PROMs renders the number of components making up the breadboard more manageable, and available software packages help you gain mastery of breadboard-building techniques.

Most schematic-capture programs produce a net list that a number of companies can use to wire a breadboard automatically **(Ref 1).** You create the design and then send off the net list at the same time you purchase the necessary components. When you receive the completed wire-wrapped panel, you place the components on the panel. You then verify the design, and as you make changes, you update the schematic. Consequently, when you complete the testing, the final design already exists in a file. You then create a final, corrected, accurate net list for the gate-array manufacturer. (For an account of one company's variation on this sequence, see **box,** "One company's approach to breadboarding.")



```
          Form type: partition        Form name:  count

  Partition: count
  Inputs: 5      Comb Outputs: 2 (2 w/feedback)       Reg Outputs: 6 (6 w/feedback)
  Total Pins Required: 13

  Output Name:                  Output Type:          Inputs Required:
  count                         Set                   c0,c1,c2,c3,c__enable,clock,
                                                      enable,up
  up                            Bidir                 s0
  c__enable                     Bidir                 s1
  sreg                          Set                   c0,c1,c2,c3,clock,dir__up,enable,
                                                      mode,pause,s0,s1
```

***Fig 1—When partitioning a design** with FutureNet's Dash-Gates, you enter the desired outputs, and the software automatically specifies the required inputs. The part required to perform this count function needs at least five inputs, two combinatorial outputs, six registered outputs, and 13 pins. A 16R6 or equivalent would work.*

The use of schematic-capture programs limits you to use of off-the-shelf SSI and MSI devices, and it often requires the conversion of the standard logic devices into the equivalent gate-array macros—another potential source of errors. Some gate-array vendors, however, are beginning to use standard TTL devices in their macro libraries, a practice which will smooth the conversion process.

One helpful breadboarding tool is FutureNet's Semicustom Development System, which runs on an IBM PC/AT with a 32-bit coprocessor board. The system helps you perform several tasks essential to the creation of digital circuitry, from design entry and simulation to the production of gate-array net lists. The system's Dash-Gates package lets you create the design using a functional description (the system allows schematic entry as well). After you've entered the design, you may either partition the design into multiple PLDs or send the net list directly to the gate-array manufacturer. If you're going to make a breadboard, you would elect the former alternative.

The partitioning of the design is semiautomatic; you make many of the decisions. You survey the design and group sections that will most likely fit into a PLD, usually by separating pure logic from that which requires latches. Then you select outputs. Dash-Gates will determine the inputs required to create the selected outputs, and it will define the number of inputs and latches required **(Fig 1).** You then select the appropriate PLD and define the input and output pins. Dash-Gates then creates a file defining the PLD. This process repeats until you have converted as much of the design into PLDs as you desire.

Right now, the system will partition only functionally entered designs. In the near future, the system will be able to convert a schematic into a functional description and then partition that description. Also, the system does not yet provide a PLD interconnect diagram automatically, but the signal names on the PLDs will match. You can then make a net list for wire-wrapping the breadboard. Soon the interconnection of PLDs will be automated, and Dash-Gates will be able to create a net list that can be used to wire the breadboard.

Once you've proven the design information on the PLD-based

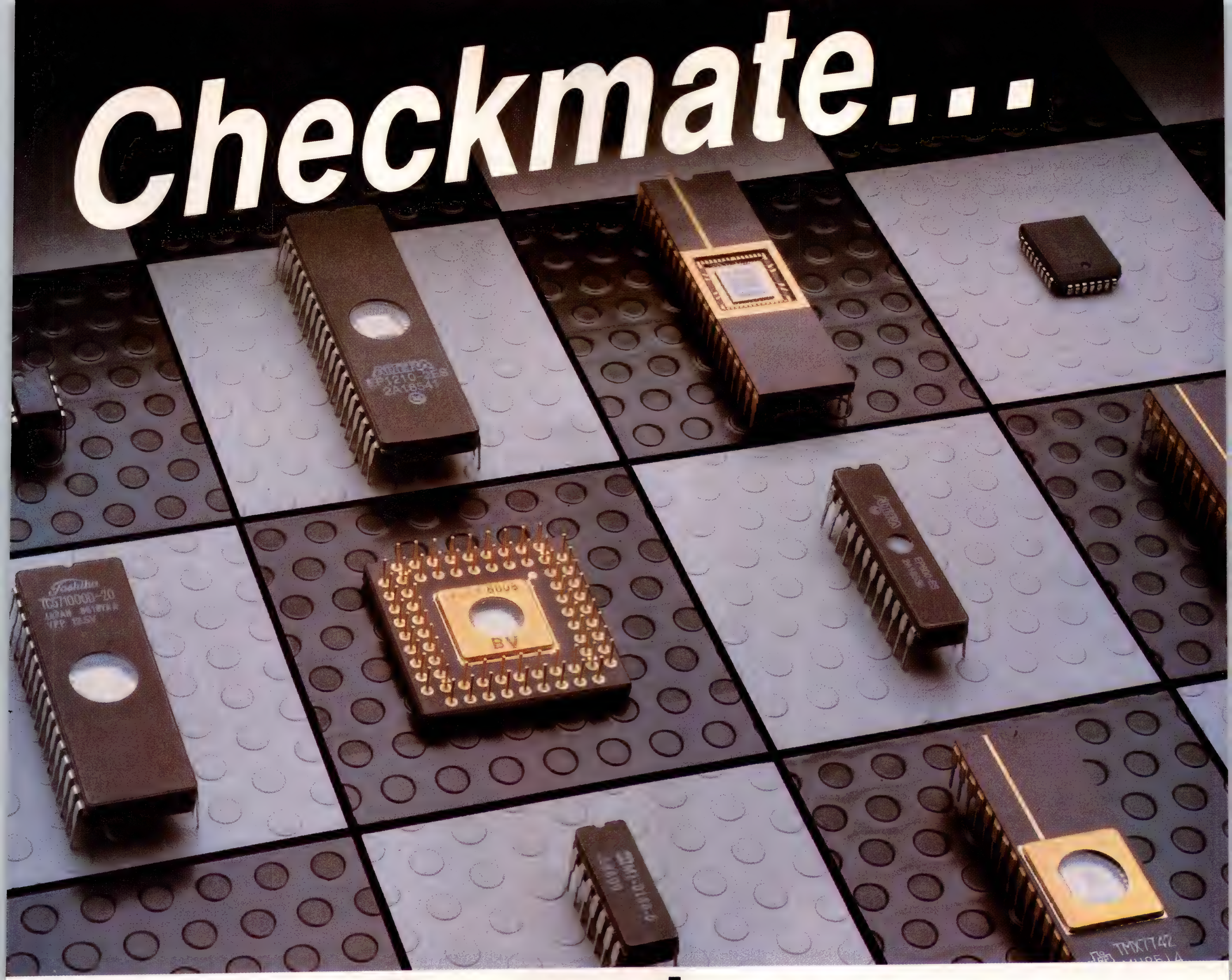
One company's approach to breadboarding

The approach to gate-array development used by Magnesys Inc (San Jose, CA), a producer of bubble-memory storage subsystems, is to use two breadboards for each gate-array design. This methodology requires a minimum of tools—an IBM PC, schematic-capture software, and a logic analyzer. It's not necessary to spend large sums of money on exotic equipment.

The engineers enter a design into a schematic-capture program, which creates a net list that an automated wire-wrapping service can use to build the first breadboard. The engineers then integrate this breadboard with the target system and debug the system until they're satisfied with its operation.

The updated schematics then undergo three types of treatment: They're sent to the wire-wrapping service, which creates the second breadboard; they're converted into the gate-array vendor's library; and they're given to someone else—another staff engineer, a consulting engineer, etc—for independent verification of the schematic translation. The design team then creates a vendor-compatible net list, as well as any other documentation the vendor requires.

When the second breadboard arrives, the design team again verifies the design in order to prove that the documentation is correct. A logic analyzer with an interface to a computer assists in the creation and editing of test patterns. The entire gate array is then simulated at the vendor's facility. The resulting documentation released to the gate-array vendor goes with a high degree of confidence on the part of the design team.



The game is over.
OMNI. The only universal programmer.

A totally new concept in PROM Programming. OAE has drawn upon 12 years of research and manufacturing experience to develop the ultimate in software configured programmers. By combining up to 64 programmable pin drivers with a new database of over 1400 parts, the software configured OMNI can program hundreds of EPROMs, EEPROMs, EAROMs, bipolar and CMOS PROMs, PLDs, microprocessors and ASICs (Application Specific ICs). *In fact, the OMNI's unique pin drivers can program and test all known programmable semiconductors, from bipolar diode arrays to ECL PLDs.* in addition, an optional parametric editor can be used to screen every device programmed to your company's own specifications.

- 100% Software Configured.
- Unlimited Free Library Updates available for *2 years.*
- Plug compatible with over 350 different computers and operating systems.
- Over 20,000 devices may be added to the OMNI's new nonvolatile library.
- Fast high voltage, high current pin drivers can supply ±1.5A continuous, and ±4.5A to ±10A peak at each pin.
- 100% laser trimmed references — no calibration is ever required.
- Over 4,000 steps of voltage and current resolution plus sub-nanosecond timing resolution to program everything from CMOS to high power bipolar and ECL devices.
- The OMNI 64 supports ALL package types, including SOs, LCCs, PLCCs, PGAs, DIPs, etc.
- Full one year parts and labor and two year software warranty period.
- The OMNI is small, portable, and easy to use.

OMNI Series starts at just $ 3250.00

NOW THAT THE HARDWARE GAME IS OVER... IT'S YOUR MOVE!

Call 1-800-828-0080 (1-800-423-8874 in CA) for a free demonstration today.

OAE

Oliver Advanced Engineering, Inc.
320 West Arden Street
Glendale, CA 91203
(818) 240-0080
TWX (510) 600-8099

CIRCLE NO 72

breadboard, you use that same information to create the fabrication data for the gate-array vendor. Again, remember: If you incorporate any changes into your design, you must update the associated file. It's vital that the file be accurate before you create the fabrication data used by the gate-array manufacturer.

When purchased as a complete system, the Semicustom Development System costs $31,880. The Dash-Gates package alone costs $5500.

Your choice: PLDs or PROMs

Another helpful logic-design tool is Kontron Electronics' LOG/iC. An IBM PC-based version ranges in price from $3990 to $9280, while a VAX-based version costs as much as $23,280. LOG/iC lets you define the design with standard Boolean equations and truth tables; with a finite-state-machine syntax; or as one of several microprogrammable sequencers. After optimizing the entered design, you create an output file that defines registered PAL devices, gates for gate-array production, PLAs, or PROMs.

If you choose to use PAL devices, you initially place those designs that won't fit into a single device into a "hyper-PAL," which is a hypothetical device that has 32 inputs, 32 outputs, and 99 product terms. The information obtained from the description of the hyper-PAL will allow you to partition the design manually into multiple devices.

If you choose to use PLAs or PROMs, you enter the design into the LOG/iC system, which automatically converts the design into a file that will define the programming pattern of the device. The system will automatically partition the design into the devices you have selected. LOG/iC provides an extensive and growing library to simplify the selection of programmable devices. No matter what device type you use, the LOG/iC system will create the appropriate programming file and allow the file to be transferred to a programmer.

Monolithic Memories Inc, which has recently entered the gate-array market, has a software package that will convert multiple-PAL designs into gate arrays. MMI's $7500 Magik (MMI Advanced Gate Array Integration Kit) software tools are available on all Daisy systems, including the Personal Logician. These tools perform the full range of required functions, from schematic entry to the creation of the tapes for the manufacture of the devices.

The Magik package incorporates the PAL Integrator, which allows you to specify and include one or more devices into the gate array. Boolean equations used to design and program the devices are the input to the PAL Integrator. The program automatically converts the equations to an equivalent hierarchical macrocell and generates the associated schematic. Each device

For more information . . .

For more information on the hardware and software tools described in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

FutureNet Corp
9310 Topanga Canyon Blvd
Chatsworth, CA 91311
(818) 700-0691
Circle No 701

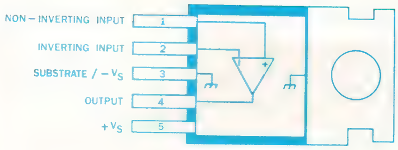
Kontron Electronics Inc
633 Clyde Ct
Mountain View, CA 94039
(415) 965-7020
Circle No 702

Monolithic Memories Inc
2175 Mission College Blvd
Santa Clara, CA 95050
(408) 970-9700
Circle No 703

Xilinx Inc
2069 Hamilton Ave
San Jose, CA 95125
(408) 559-7778
Circle No 704

SPRAGUE
POWER OP AMPS

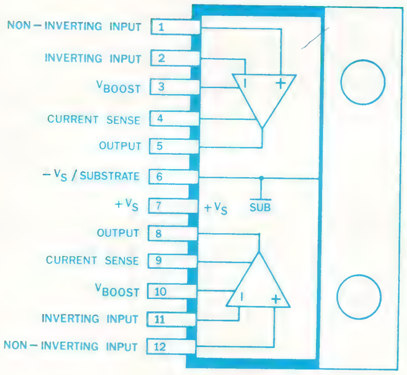
For:
Linear Servo Amplifiers
Bipolar Voltage Regulators
AC and DC Motor Drivers
Audio Power Amplifiers
Voice-Coil Motor Drivers
Wien Bridge Power Oscillators



ULN-3751Z
POWER OPERATIONAL AMPLIFIER

- Peak Output Current to ±3.5 A
- Operating Supply Range ±3 V to ±15 V
- Unity-Gain Stable
- 90 dB Typical Open-Loop Gain
- High Common-Mode Input Range
- Thermal Shutdown Protection

Write for Engineering Bulletin 27118.1 or:
CHECK 118 ON READER SERVICE CARD



ULN-3755W
DUAL POWER OPERATIONAL
AMPLIFIER

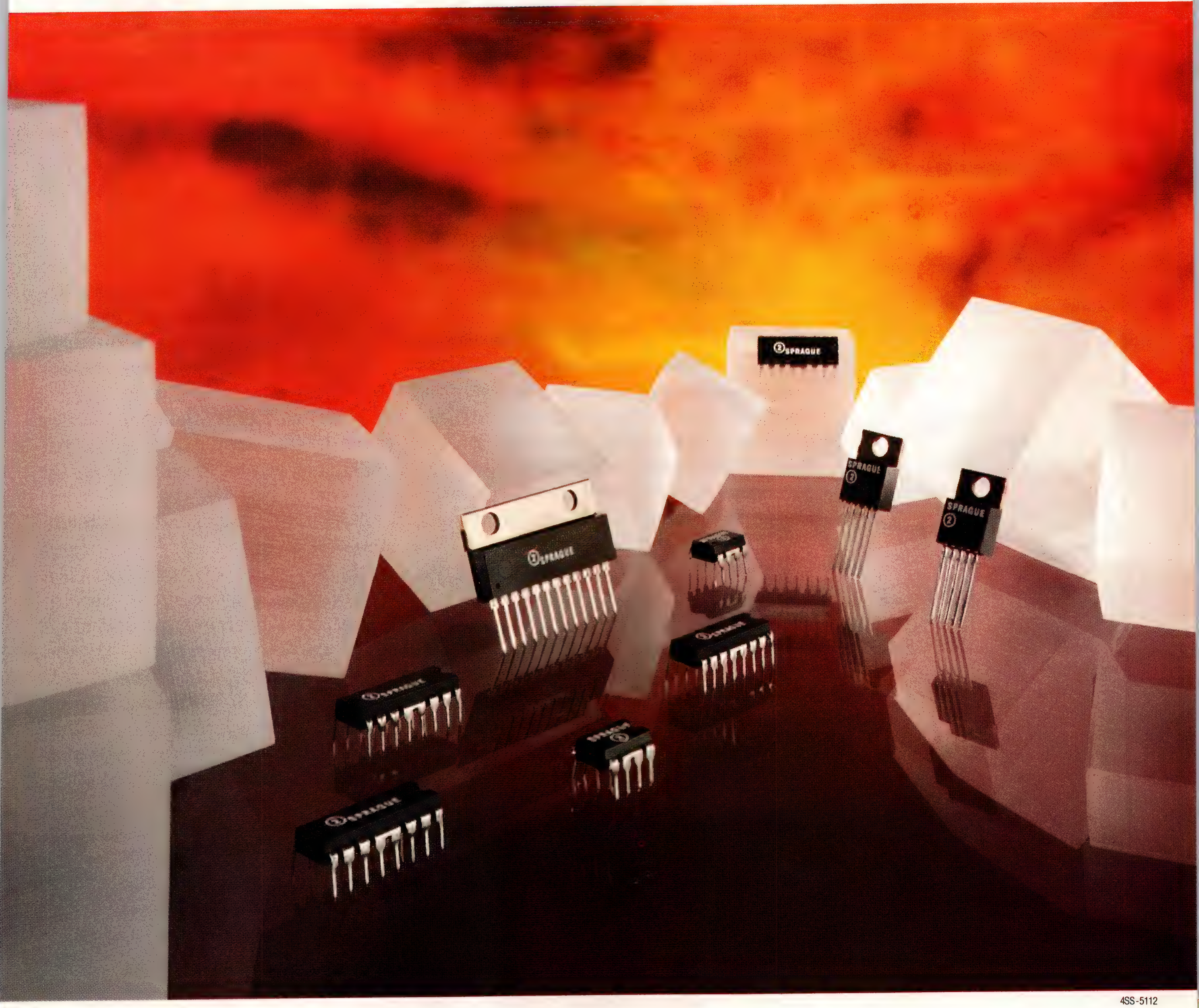
- Peak Output Current to ±3.5 A
- Output Protection Diodes
- Supply Boost or Bootstrapping
- High Output Swing
- ±3 V to ±20 V Operation
- Unity-Gain Stable
- Output Current Sensing
- Low Crossover Distortion

Write for Engineering Bulletin 27118.10 or:
CHECK 157 ON READER SERVICE CARD

SPRAGUE
THE MARK OF RELIABILITY

4SS-5113

BUILDING BLOCKS.



4SS-5112

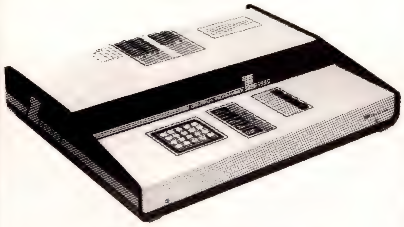
SPRAGUE POWER OP AMPS SIMPLIFY DESIGNS, BY DESIGN.

Six new Sprague power operational amplifiers meet the growing need for monolithic linear interface drivers by providing a low-component-count solution to high-current design challenges. The new devices are capable of driving loads up to ±3.5 A and ±20 V. These single and dual-channel power op amps are universal building blocks that merge the versatility of small-signal op amps with the brute force capability of power drivers. Comprehensive protective features are provided on-chip. Recommended applications include use with servo systems, dc motors, single and multi-phase ac motors, disc drives, audio systems, CRT deflectors, and voltage regulators. *Sprague Electric Company, a Penn Central unit,* World Headquarters, Lexington, MA. For Brochure WR-206 and applications information on Power Operational Amplifiers, write to Technical Literature Service, Sprague Electric Company, 41 Hampden Road, P.O. Box 9102, Mansfield, MA 02048-9102. For applications assistance, call Ron Lutz at (617) 853-5000.

SPRAGUE
THE MARK OF RELIABILITY

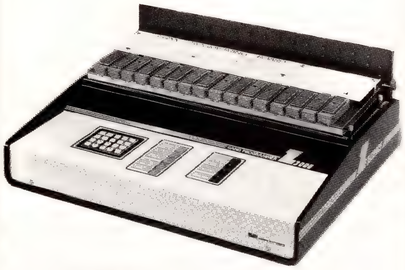
CIRCLE NO 73

AMERICA'S BEST PROGRAMMERS



Z-1000B UNIVERSAL PROGRAMMER

- Over 600 PLDs, EPROMs, EEPROMs, Bipolar PROMs and INTEL MCUs.
- Separate D/A channels for each pin.
- Upgradeable PROM based software.
- Stand alone or PC/XT/AT operation.
- Two independent RS-232 ports.
- 64K or 256K bytes of DATA RAM.
- EXATRON handler interface is standard.



Z-3000 HIGH VOLUME GANG/SET PROGRAMMER

- 14,000 27256s programmed per day.
- 32 EPROMs simultaneously with 1 to 8 DATA BLOCKS.
- 16 Intel or Motorola MCUs at a time.
- 64K to 256K bytes of DATA RAM.

Z-1200B TWELVE SOCKET GANG/SET PROGRAMMER

- 2716 – 27512, 1 to 4 DATA BLOCKS.
- 64K to 256K bytes of DATA RAM.
- Software personality. No plug-ins.

Z-2500B IN-CIRCUIT MEMORY CARD PROGRAMMER

- Programs up to 32 memory cards with EPROMs or microcomputers at a time.
- Two 1.2 Mbyte DSDD floppy disk drives. Optional 20 Mbyte hard disk.
- Turnkey systems include programmer, terminal, custom interface hardware and software.
- Simple menu driven operation.

ZAP SERIES engineering and field service programmers for EPROMs to 27C1024, Intel and Motorola microcomputers.

Z-400 economical bipolar PROM and EPROM programmer.

SUNRISE ELECTRONICS, INC.
524 South Vermont Avenue
Glendora, California 91740
(818) 914-1926

CIRCLE NO 19

has a separate schematic, which resides in a separate file. All of the devices to be used in a gate array are contained in a single directory that defines the entire gate array.

The PAL Integrator supports more than 60 of MMI's PAL device types. This measure of support allows you to create a design using PLDs and standard logic, test and verify the design in breadboard form, and then place the design into a gate array.

Emulators, superbreadboards

The ideal approach to gate-array development would be to retain the benefits of building a breadboard without actually building it: You would employ CAD tools to design the circuitry and simulate worst-case timing and racing conditions, monitor the operation of the gate array in the actual system in real time, and instantly modify the gate array where required. This approach would be possible if an available emulator could replicate the behavior of the gate array, allow the user to monitor all of the circuitry within the array, and facilitate modifications.

Coming very close to the ideal is Xilinx's development system for its logic-cell array **(Ref 2)**. The $3600 XC-DS21 design editor runs on an IBM PC/XT or PC/AT and provides a design environment for the development of an application using the logic-cell array. When you complete the design, you can download the data into the actual device directly from the PC, using the download cable provided and three pins of the device.

What gives the XC-DS21 its power and versatility, however, is the $6300 XC-DS24 Xactor in-circuit emulator, which allows you to test and modify a design quickly. You can evaluate the entire target system, including the logic-cell array's interaction with software and asynchronous events.

Once you've entered, simulated, and routed your design, you plug the Xactor into the target system and run the design in real time. At any time you can upload the internal state of the logic-cell array into the PC for analysis (by itself, the design editor does not allow uploading of files).

Depending on your design, you can use the editor and emulator to verify the target system and create a comprehensive list of test vectors by reading the internal state of the emulator after each step. Such a list proves useful when you want to place the design into a gate array and perform simulation and device testing.

Current Xilinx logic-cell arrays have 1200 or 1800 usable gates. An 8000-gate version should appear by the end of 1987.

Sometimes it's just not possible to build a breadboard. With many technologies, for example, there is a big difference between the speed of a discrete-IC version and that of its gate-array counterpart. At the upper limits of speed, the breadboard will be significantly slower than the final design. When the final system simply won't operate at a slower speed, the breadboard often isn't useful, because it can't keep up with the data coming in. Despite the existence of such cases, however, breadboarding remains viable for a sufficient number of designs to warrant your careful consideration.

EDN

References

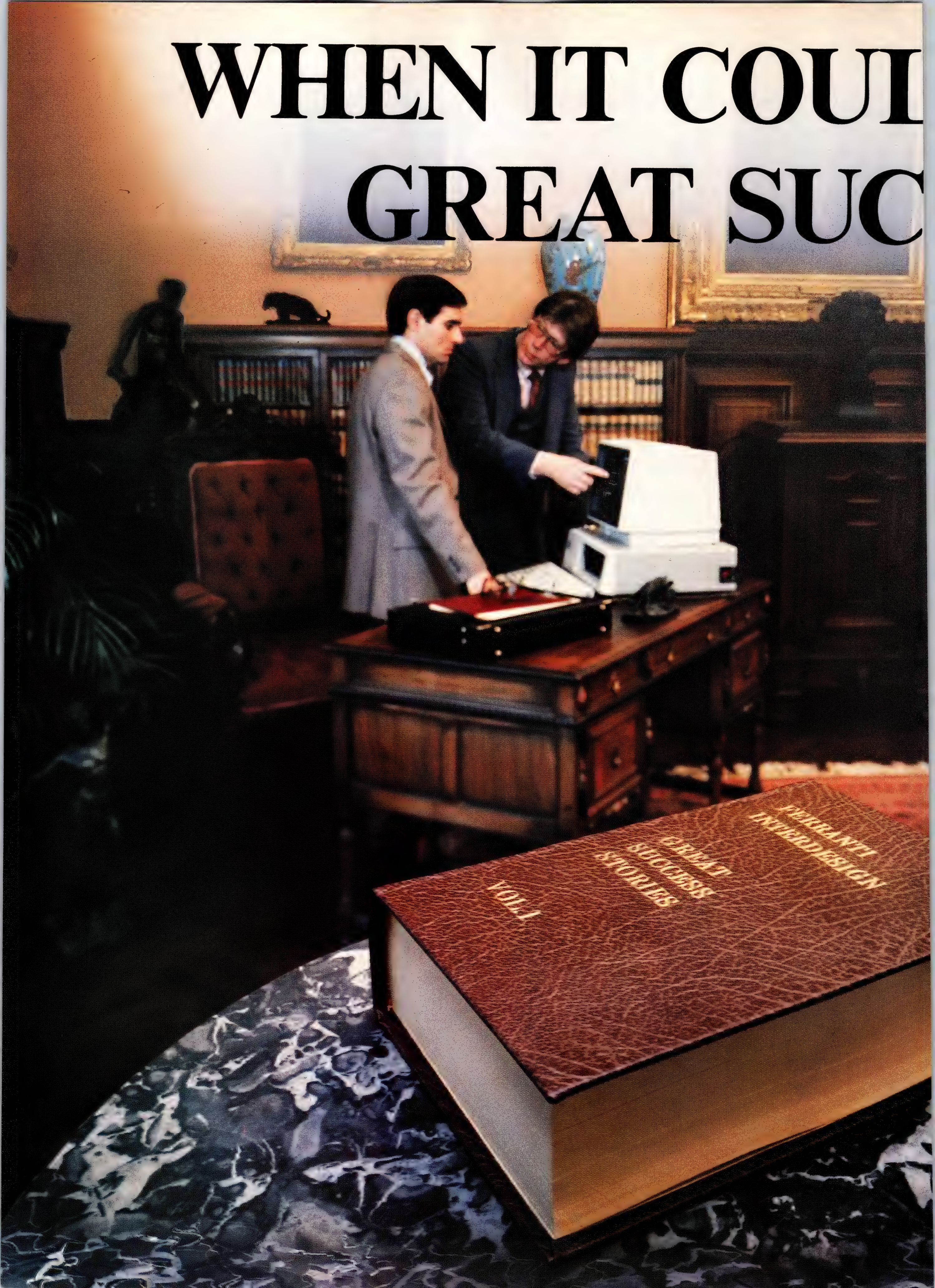
1. Ormond, Tom, "Professional wire-wrapping services ease prototype-circuit assembly tasks," *EDN*, September 18, 1986, pg 115.
2. Wynn, Pardner, "In-Circuit Emulation for ASIC-Based Designs," *VLSI Systems Design*, October 1986, pg 38.
3. Crisafulli, Kelle, "A Pin-Logic Gate Array For a Programmable Logic Programmer," *VLSI Systems Design*, October 1986, pg. 30.

Article Interest Quotient
(Circle One)
High 500 Medium 501 Low 502

Is your semicustom design
often treated like . . .

JUST
ANOTHER
GOOD
MYSTERY?

WHEN IT COUL
GREAT SUC



BE ANOTHER
ESS STORY

Ferranti Interdesign—the industry leader
Since 1972 when Interdesign introduced the worlds first semicustom IC array for integrating linear circuits onto silicon, we have continued to provide the highest-quality, highest-performance semicustom linear, digital and digital/linear combination integrated circuits in the industry.

With an impeccable track record of over 5,000 successful integrations, Ferranti Interdesign has proven that our *easy-to-use* CAD-supported approach to semicustom circuit design can be both pleasurable and profitable—stripping away the mystique surrounding semicustom while turning *your* design into another in our long line of great success stories.

Continuing support—from design through production.
Ferranti Interdesign's total commitment to quality, military screening, advanced CAD systems, extensive engineering support and design aids are your assurance that at every stage of the program we will support you in achieving your goals of cost-reduction, space-reduction, power-reduction and design security while maintaining your competitive edge.

The industry's broadest selection of ASIC's.
Ferranti Interdesign offers the industry's broadest selection of semicustom integrated circuits and technologies for both linear and digital applications, in either bipolar or CMOS technologies. In addition we also offer the most advanced high-performance digital/linear combination circuits available. The growing need to manipulate larger amounts of data is making these high-speed, low-power ASIC's increasingly popular.

Full CAD support.
As a sophisticated designer of analog and digital circuits you know the importance of high-quality, CAD-supported design tools. Ferranti Interdesign provides the designer with a variety of user-friendly design system options for both analog and digital circuits. With the customer always clearly in mind, Ferranti Interdesign's CAD is dedicated to the use of *proven* commercially available hardware and software, such as: the Mentor™, Sun™ or Apollo® Workstations, VAX™-based workstation, IBM AT/XT®, Analog Workbench™, FutureNet®, or PSpice™.

So, when it comes to *your* design, don't let it become just another good mystery, call Ferranti Interdesign today and get your name in our latest volume of great success stories.

For more information about Ferranti Interdesign and our quality products, please call us at (408) 438-2900.

Solutions in Silicon

FERRANTI
Ferranti Interdesign Inc
Sequoia Research Park
1500 Green Hills Road
Scotts Valley, CA 95066

CIRCLE NO 76

Mentor is a trademark of the Mentor Graphics Corp., Sun is a trademark of Sun Microsystems, Inc., Apollo is a registered trademark of Apollo Computers, Inc., VAX is a trademark of the Digital Equipment Corp., IBM, AT & XT are registered trademarks of the IBM Corp., Analog Workbench is a trademark of Analog Design Tools, Inc., FutureNet is a registered trademark of FutureNet Corp., Pspice is a trademark of the MicroSim Corp.

ZyMOS puts Big Blue

How do you get 100% compatible PC-AT functionality into your system?
Stuff it!

That's right. Now you can add PC-AT functionality to your system by stuffing it with the PC on A Chip—or POACH CHIP, as we call it. Up to 25,000 gates. Another CMOS innovation from ZyMOS—the leader in SuperCell™ technology.

Actually it's two chips, that replace over 50 of the 96 devices (53%) on a PC-AT motherboard, including all the microprocessor peripherals*. Two chips freeing up all that board space. Now, what does that mean to you?

Among other things—you can improve the performance, functionality and cost of your board or system. And make it more reliable too! Since POACH is implemented in high speed CMOS, you can also expect a reduction in heat and power consumption. Imagine your system performing at 12 MHz!

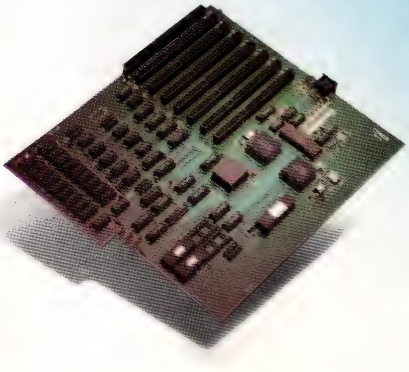
ZyMOS PCs on Chips are standard products so you can design them in fast. Getting your offerings to market—ahead of time. And ahead of your competition.

POACH Chip sets are only part of the story. Since they are implemented with cells from our SuperCell library, you can integrate any of your iAPX designs as we did the PC-AT. These cells are 100% functionally compatible with original off-the-shelf microprocessor peripherals they replicate. And can be interfaced to RAMs, ROMs, PLAs and other cells from our 1.8μ CMOS library.

Besides the POACH peripherals, our more complex SuperCells also include the 80C49 Microcontroller and the 29C01 4-bit Microprocessor Slice.

At ZyMOS, we support you all the way. We manufacture all our own parts, then guarantee them with our Zyp Silicon Level Simulator that assures your circuit design will perform as planned. And our FAEs are always ready to assist you.

Be there—ahead of time. Contact one of our local sales offices to check on the availability of the "right stuff". The POACH Chip Evaluation Kit. It includes the two chip set plus a surrogate motherboard. Put Big Blue compatibility in your black box now—and turn your competition green with envy.



POACH AT CMOS Peripherals

*8237A	DMA Controller
8254	Programmable Interval Timer
8259A	Programmable Interrupt Controller
8284	Clock Generator
82284	Clock Generator and Ready Interface
82288	Bus Controller
LS612	Memory Mapper
6818	Real-Time Clock/RAM

in your black box.

ZyMOS
Ahead of Time.

ZyMOS Corporation
477 North Mathilda Avenue
Sunnyvale, CA 94086
Phone: (408) 730-5400
TWX: 910-339-9530 ZyMOS SUVL

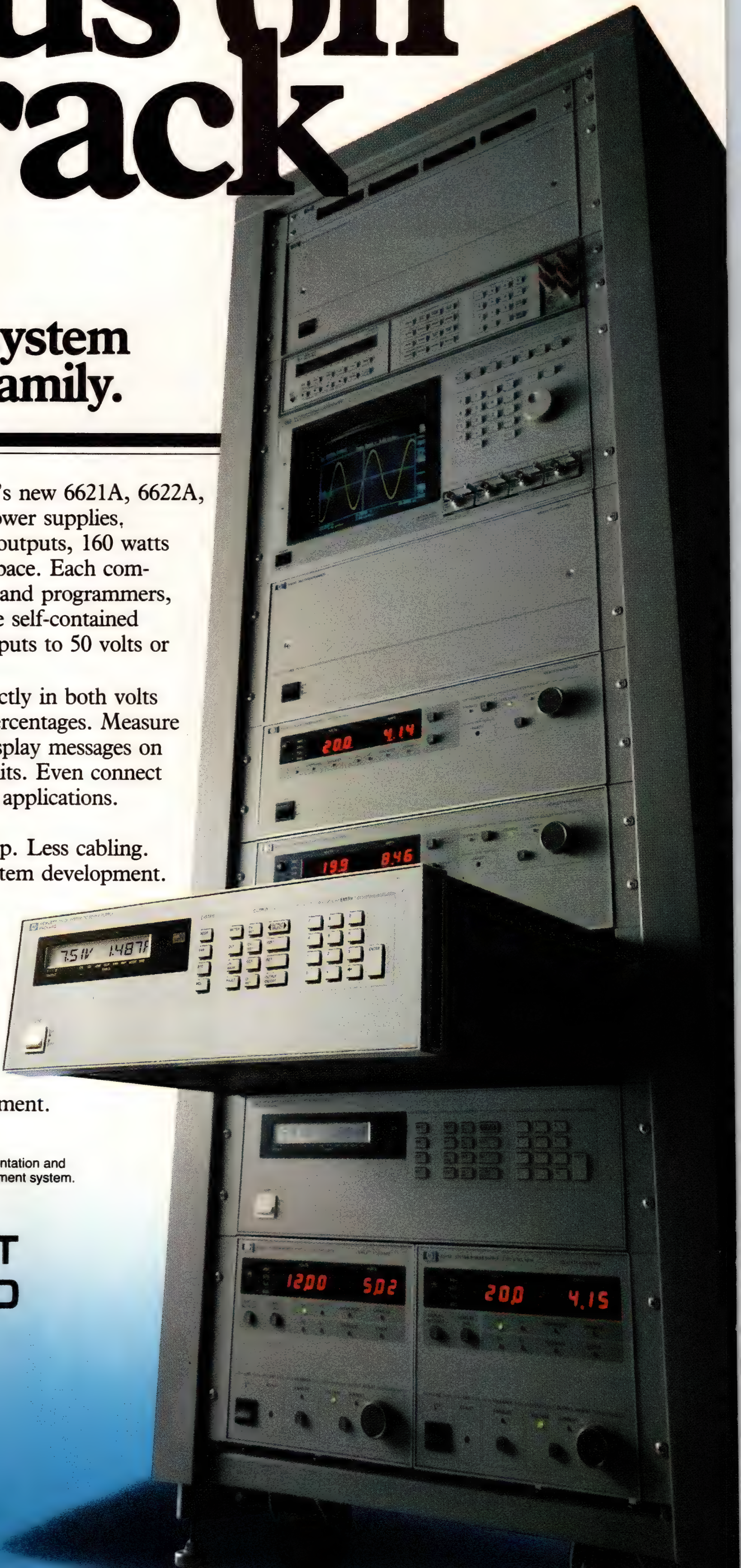
ZyMOS Sales Offices:
Sunnyvale, CA, (408) 730-5400
Los Angeles, CA, (818) 331-0604
Chicago, IL, (312) 272-7855
Boston, MA, (617) 263-7873
Atlanta, GA, (404) 662-1579
Fort Lauderdale, FL, (305) 272-1509

IBM is a registered trademark of International Business Machines Corporation.

CIRCLE NO 78

Put us on the rack

Introducing the HP 6621A-6624A system DC power supply family.



You'll save space, time, and money with HP's new 6621A, 6622A, 6623A, and 6624A multiple-output system power supplies.

They offer you up to *four* low-noise DC outputs, 160 watts total, in one box requiring just 5¼"of rack space. Each combines the functions of several power supplies and programmers, a scanner, current shunts, and a DVM in one self-contained package with a common HP-IB address. Outputs to 50 volts or 10 amps are available.

It's easy for you to program outputs directly in both volts and amps instead of cryptic mnemonics or percentages. Measure and read back actual voltage and current. Display messages on an LCD. Set overvoltage and overcurrent limits. Even connect outputs in series or parallel for higher-output applications.

The bottom line?

More capability in less space. Faster setup. Less cabling. *And* low cost of ownership at all stages of system development.

Call HP today!

Put us on the rack starting today...all models are in stock now! For more information and our DC Power Supply Catalog, contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

DESIGNED FOR HP-IB SYSTEMS HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

HEWLETT PACKARD

CIRCLE NO 85

EI15617

Electro/87 and Mini/Micro Northeast programs will examine divergent topics

Tom Ormond, *Senior Editor*

The hallmark of this year's Electro and Mini/Micro Northeast conferences is its diversity. The theme of the professional programs is "Emerging Tools and Technologies for the Electronic Society of the Future"; you'll encounter numerous tutorials, sessions, and minitutorials pertaining to both. During the 36 sessions, speakers will present more than 150 papers (see **box**, "Information on programs and registration," pg 98).

Tutorials augment schedule

Electro/87 and Mini/Micro Northeast will run from April 7 to 9 at the Jacob Javits Convention Center in New York City. On Monday, the day preceding the formal start of the conferences, the IEEE Metropolitan Sections Activities Council and Electro/87 are co-sponsoring five tutorials. As of March 19, prices for the tutorials range from $225 to $355 (IEEE members) or $280 to $410 (nonmembers). These fees include course materials and lunch as well as show registration.

One tutorial, dealing with today's high-speed transmission systems, will discuss how telecommunications technology is moving metropolitan services into the digital realm in anticipation of the Integrated Digital Services Network (ISDN). This tutorial will have four speakers: One will talk about high-speed fiber-optic-based systems; another will discuss advances in fiber-optic technology; the third will identify how to use fiber-optic systems in LANs; and the fourth will offer specific applications as they relate to an end-user of high-speed services.

During the second tutorial, which will cover teleconferencing, you'll hear about the technical aspects of designing a teleconferencing system, including acoustics, echo cancellation, lighting, display technologies, equipment control, video-system design, audio-system design, and communication-system interfaces. Particular emphasis will be on image-data compression and satellite modem design.

The third tutorial will raise questions about monolithic microwave integrated circuits (MMICs), which are influencing traditional component-design techniques as they relate to communication, defense, and industrial applications. This session will address what MMICs mean to an engineer and how they might affect system designs.

The fourth tutorial will look at the history of radar, its present status, and its potential applications for the future. Equally applicable to new as well as experienced engineers, this tutorial will cover both technology and systems.

In the fifth tutorial, which is on µP architecture, you'll learn about ongoing research into reduced instruction set computers (RISCs). This meeting will analyze the prominent design issues pertaining to the RISC architecture.

Raise the Titanic

If you're planning to start off the conference at the keynote breakfast, scheduled from 9:00 to 10:30 AM on April 7 at the Marriott Marquis Hotel, you'll get a special treat: Dr Robert Ballard of the Woods Hole Oceanographic Institution in Massachusetts is the featured speaker. In addition to finding the Titanic, he has led or participated in over 50 deep-sea expeditions, and he has published 40 scientific articles.

Semicustom is on the agenda

Between April 7 and April 9, you'll have 36 professional programs from which to choose. Several sessions will concentrate on components such as gate arrays, PLDs, smart ICs, and LSI/VLSI parts. Other sessions will address advances in system architecture, logic, memory, processors, and number crunchers.

Still others will discuss custom and semicustom design centers, tools, and design-verification techniques, showing how they will have an impact on analog, digital, and communications systems. Sessions on computer languages, software-based systems, interface standards, manufacturing technologies (such as surface mounting), and the pros and cons of offshore vs domestic manufacturing and assembly are also scheduled.

One especially interesting session, on high-definition television, will include visual displays showing how to apply the technology to film, television, and printing. A minitutorial on computer-graphics video will present computer-generated 2- and 3-dimensional animated images as well as demonstrate shading and lighting effects.

Six additional minitutorials will deal with a variety of subjects. Some, for instance, will give broad overviews of emerging technologies such as computer graphics and optoelectronics. Others will review design guidelines for dealing with electromagnetic shielding and circuit stability.

Social issues on the docket

The professional programs at Electro and Mini/Micro Northeast won't neglect social issues, either. For example, you'll find sessions that will examine artificial intelligence and evaluate the chances of AI supporting (or supplanting) human thinking. A panel discussion will address ethical issues and ways to alleviate the conscientious engineer's susceptibility to criticism. You'll also have the chance to attend a session on the legal aspects of protectionism and another that addresses financial issues of interest to the new entrepreneur. **EDN**

Article Interest Quotient
(Circle One)
High 506 Medium 507 Low 508

LOW PROFILE/HIGH DENSITY SWITCHING POWER

Case 23

Up to 600 Watts
3″x5″x14.25″
Main Channel Up to 80A
Auxiliary Mag Amp Outputs

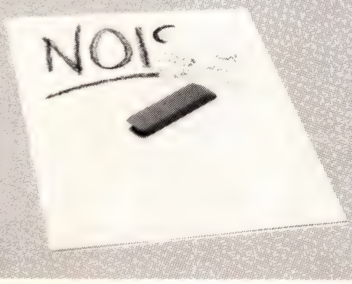
400 to 600 Watts from up to 7 fully regulated outputs in a package that's sized to fit your OEM requirements. With the standard features and options you are looking for: N+1 redundancy; EMI filtering to FCC 20780 Class A; Main channel pre-load; A ball bearing, brushless DC fan; DC input models. International safety approvals and field strappable ac input voltage to fit anywhere in the world. The Case 23 from Qualidyne—try it on for size.

THE SWITCHER FIT FOR YOUR NEEDS

Qualidyne

QUALIDYNE SYSTEMS, INC.
3055 Del Sol Boulevard, San Diego, CA 92154
(619) 575-1100 Telex: 709 029 FAX: 619 429-1011
(800) 445-0425 In Calif. **(800) 237-6885**

CIRCLE NO 20



electrocube

RC NETWORKS

. . . Noise Eradicators

Shush your circuits quickly and economically with Electrocube's standard line of more than 400 metal can and encapsulated, UL Recognized, RC Networks. Voltage ranges of 200 to 1,000 VDC and 125 to 480 VAC are available, with special heavy duty units ranging from 400 to 2,000 VDC and 120 to 480 VAC. So, if you want your circuits to be "seen and not heard"... write or call Electrocube, 1710 So. Del Mar Ave., San Gabriel, CA 91776; Tel. (818) 573-3300.

CIRCLE NO 21

Electro/87, Mini/Micro Northeast product highlights

More than 700 companies will be displaying their products at the Jacob Javits Convention Center. The brief product descriptions that follow hint at the diversity of the products you'll be able to see; for more detailed coverage, watch for EDN's March 31 issue.

Test and measurement instruments

The MW920A portable optical time-domain reflectometer from Anritsu (Oakland, NJ) features "EZ" keys that allow you to quickly select and set measurement conditions. The unit's 3-nsec pulse width virtually eliminates any dead zones, allowing you to locate fiber faults within 3m over distances of 40 km. You can store or recall as many as five sets of displayed data (including measurement conditions and fiber traces) in the MW920A's memory.

The SE 571 digital scope from BBC-Metrawatt/Goerz (Bloomfield, CO) simplifies the task of getting hard-copy output from a CRT: It has a built-in thermal printer that prints all the information from the CRT, complete with protocol of the information, within 10 sec. Equipped with two 25-MHz A/D converters, the SE 571 displays two signals (10 MHz max) via sine interpolation. For digital-circuit analysis, it provides as many as eight logic channels. Because of its almost-instantaneous printout capability, the scope also functions as an 8-channel logic recorder.

Keithley Instruments (Cleveland, OH) will introduce its Model 194, a programmable high-speed sampling voltmeter. Operating in the waveform-analyzer mode, it can digitize signals at sampling rates as high as 1 MHz with 8-bit resolution. Operating as a voltmeter, it has a high-resolution 16-bit (4½-digit) mode for sampling rates ranging to 100 kHz. It also has a wide dynamic range in the 16-bit mode: 10 µV to 200V. These capabilities reside in a full-rack system-voltmeter form factor.

Krohn-Hite Corp's (Avon, MA) Model 2100 synthesized-function pulse generator is an IEEE-488-compatible programmable instrument with a 0.01-Hz to 31.16-MHz frequency range, 0.00005% frequency accuracy, and 7-digit resolution. The 2100 includes nonvolatile memory that allows you to store and recall as many as 75 complete front-panel setups under either program or front-panel control.

The TA2000 from Gould (Cleveland, OH), an 8-channel thermal-array recorder, features a fixed array of thermal writing styluses that provides a recording width of 200 mm max with 8-dot/mm resolution. The unit's simple front panel provides immediate and convenient access to common recorder controls.

At its booth, Western Graphtec (Irvine, CA) will be displaying the TDA 3500, an 8-channel transient-data-acquisition system designed to capture and store high-frequency nonrepetitive data. The unit can operate in a stand-alone mode, in series with an oscillographic recorder, or in parallel with real-time recorders. Direct reading controls, conveniently grouped by function, eliminate the need to make calculations during setup and playback.

Integrated circuits

Amperex Electronic Corp's (Smithfield, RI) line of p-channel vertical DMOS FETs claim 4.5Ω drain-to-source on-resistance at a gate to source voltage of 10V, 4-nsec turn-on times, and maximum drain-to-source voltage ratings to −60V.

GE/RCA Solid State (Somerville, NJ) will present 8-bit R/2R ladder-type D/A converters for systems that run at video speeds. Two versions are available. The CA3338 specs integral and differential linearity errors of 1 and ¾ LSB, respectively, and the CA3338A guarantees ¾ and ½ LSB for the same parameters. Both types can operate at a typical digital-input update rate of 50 MHz.

Mitel Semiconductor's (Kanata, Ontario, Canada) MT8930, a complete S interface chip, conforms to CCITT I.430 recommendations for the ISDN's S and T reference points. The subscriber-network interface circuit operates from one 5V supply, is fabricated using low-power ISO^2 CMOS technology, and is available in a 28-pin DIP and PLCC.

Computers and peripherals

Applied Microsystems Corp (Redmond, WA) will display a high-speed SCSI interface option for its ES 1800 family of in-circuit emulators. The board will support the emulator-to-host interface electrically and logically in both the single-ended and differential modes. It'll also support bus arbitration, thereby allowing several initiators and targets to use the same physical bus.

The DVME-602R from GE/Datel (Mansfield, MA) is an intelligent analog input board specifically designed for RTD measurements in VME Bus-based systems. An internal RTD excitation current eliminates lead-resistance errors. The onboard µP linearizes and scales the digitized RTD values and outputs a binary quantity to the VME Bus host computer. You can select the binary value to directly represent a temperature value in either degrees Centigrade or Fahrenheit.

Information on programs and registration

Electro/87 will take place Tuesday, April 7 to Thursday, April 9, 1987, at the Jacob Javits Convention Center in New York City. Mini/Micro Northeast will run concurrently at the same location. This year, the Electro and Mini/Micro exhibits (and sessions) are under one roof. Over 700 exhibits will be on display from 10:00 AM to 6:00 PM on Tuesday and Wednesday and from 10:00 AM to 5:00 PM on Thursday.

If you register at the door, the cost for both conferences is $10 for IEEE members and $20 for nonmembers. This fee includes all Electro and Mini/Micro Northeast professional-program sessions and minitutorials, but not the tutorials held on Monday. Tickets to the keynote breakfast, which will be held Tuesday at 9:00 AM at the Marriott Marquis Hotel, are $20.

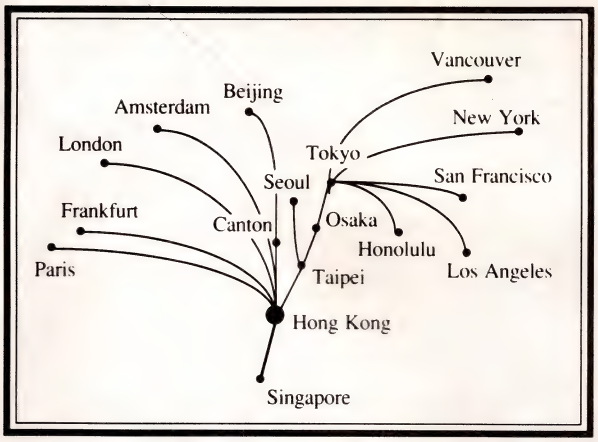
For more information, contact Electro-Mini/Micro Northeast, 8110 Airport Blvd, Los Angeles, CA 90045. Phone (213) 772-2965.

PROFESSIONAL-PROGRAM SESSIONS

DATE/TIME	ELECTRO	MINI/MICRO	MINITUTORIALS
APRIL 7 TUESDAY 10:00 AM TO 12:00 PM	SOCIAL IMPLICATIONS OF ARTIFICIAL INTELLIGENCE—SESSION 1	DESKTOP PUBLISHING BY ENGINEERS—SESSION 2 MEMORY AND MEMORY SUPPORT—INNOVATIONS AND DEVELOPMENTS—SESSION 4	EVERYTHING YOU MIGHT NEED TO KNOW ABOUT METASTABILITY—SESSION 3
1:30 PM TO 3:30 PM	SUPPORTING THE ETHICAL ENGINEER—SESSION 5	USING ADA IN REAL TIME APPLICATIONS—SESSION 6 BUILDING NUMBER-CRUNCHERS WITH LSI DATA-PATH ELEMENTS I—SESSION 7	GROUNDING AND SHIELDING ELECTRONIC INSTRUMENTATION—SESSION 8
4:30 PM TO 6:30 PM	TECHNOLOGY AND LAW—SESSION 9	RISCY BUSINESS—SESSION 10 BUILDING NUMBER-CRUNCHERS WITH LSI DATA-PATH ELEMENTS II—SESSION 11 CACHE MEMORY AND FIFO ARCHITECTURES FOR HIGH-PERFORMANCE COMPUTER SYSTEMS—SESSION 12	
APRIL 8 WEDNESDAY 10:00 AM TO 12:00 PM	AMERICAN MANUFACTURING: OUR COMPETITIVE EDGE—SESSION 13 ADVANTAGES OF ASIC DESIGN CENTERS—SESSION 14 ADVANCES IN CMOS STRUCTURAL SYSTEM DESIGN—SESSION 15		FIBER OPTIC SENSOR TECHNOLOGY—SESSION 16
1:30 PM TO 3:30 PM	OFFSHORE OPPORTUNITIES TO REDUCE COSTS AND EXPAND MARKETS INTERNATIONALLY—SESSION 17 ANALOG DESIGN MADE EASY WITH CAE—SESSION 18	NEW ALTERNATIVES IN USER PROGRAMMABLE LOGIC DEVICES—SESSION 19	CURRENT DIRECTIONS IN LIGHTWAVE COMPONENTS AND SYSTEMS—SESSION 20
4:30 PM TO 6:30 PM	ASSURING SUCCESS IN NEW VENTURES—SESSION 21 NEW APPLICATIONS FOR ELECTRO-OPTICAL COMPONENTS—SESSION 24	PROGRAMMABLE LOGIC FOR THE FUTURE—SESSION 23	OPTIMIZING SEMICUSTOM DESIGN—SESSION 22
APRIL 9 THURSDAY 10:00 AM TO 12:00 PM	DIGITAL SIGNAL PROCESSORS: PRODUCTS AND APPLICATIONS—SESSION 27	ADVANCES IN INNOVATIVE PLD ARCHITECTURE AND THEIR BENEFITS FOR SYSTEM DESIGN—SESSION 26 MULTIBUS II: THE MESSAGE PASSING COPROCESSOR (MPC) AND SYSTEM DESIGN—SESSION 28	INTRODUCTION TO REALISTIC COMPUTER GRAPHICS—SESSION 25
1:30 PM TO 3:30 PM	DESIGN AUTOMATION FOR INTEGRATED CIRCUITS—SESSION 30 SMART POWER IC's FOR MILITARY AND COMMERCIAL APPLICATIONS—SESSION 32	NEW STANDARD DSP CHIPS ENHANCE TELECOMM DESIGN—SESSION 31	COMPUTER GRAPHICS FILM SHOW—SESSION 29
4:30 PM TO 6:30 PM	HIGH DEFINITION TELEVISION APPLICATIONS—SESSION 33 BEYOND SURFACE MOUNT: SILICON INTERCONNECT SYSTEM PROVIDES HIGHER DENSITIES AND IMPROVED PERFORMANCE—SESSION 36	COMPUTER AIDED TEST AND DESIGN VERIFICATION: A REVIEW OF CURRENT TECHNIQUES AND APPLICATIONS—SESSION 34 HIGH SPEED PROGRAMMABLE LOGIC EASES NEXT GENERATION SYSTEM DESIGN—SESSION 35	

JOIN THE 1987 FAR EAST ELECTRONICS TECHNOLOGY TOUR

AND DEVELOP NEW PRODUCTS AND MARKETS IN THE FAR EAST



Hundreds in the electronics industry have taken advantage of Commerce Tours International's tours to the Orient. This year — our 11th year in the business — you, too, can develop new products, markets and sources in the Far East.

You'll attend major business seminars and electronics shows. Meet your foreign competitors in the Pacific Rim. Gather ideas. Exchange observations. It's truly a business opportunity you won't want to miss!

DATE: October 3–18, 1987

VISIT: Japan, Taiwan, Korea and Hong Kong
Optional extensions:
A: Singapore
B: Canton and Beijing, China

PROGRAM HIGHLIGHTS:

VISIT ELECTRONICS SHOWS

- Japan Electronics Show
- Korea Electronics Show
- Taiwan Electronics Show
- Canton Trade Fair
- Singapore Electronics Show

ATTEND BUSINESS SEMINARS

- Electronics Technology Update Seminar
- Korea Business Opportunities Seminar
- Taiwan Business Opportunities Seminar
- China Business Opportunities Seminar
- Singapore Business Opportunities Seminar

PLUS

- Visit factories and research facilities
- Attend business meetings with foreign companies

DEPARTURE CITIES:

Departures will be available from major U.S., Canadian and European cities via regular flights.

PRICE:

$3,130 from West Coast including airfare, hotel accommodations, daily American breakfast, five dinners, transportation to/from show grounds, airport/hotel transfers and all business programs as outlined above. Seminar fees are additional.

ORGANIZED BY:

Commerce Tours International, Inc.

FOR MORE INFORMATION, PLEASE CONTACT ONE OF THE FOLLOWING OR RETURN THIS COUPON

NAME ____________________

COMPANY ____________________

DEPARTMENT/TITLE ____________________

ADDRESS ____________________

CITY __________ STATE ____ ZIP ______

TELEPHONE ____________________

TELEX __________ FAX __________

EDN031887

IN U.S.A

Commerce Tours International
870 Market Street
Suite 920
San Francisco, CA 94102
Tel: (415) 433-3072
Attn.: Bob Chang

IN CANADA

Plesman Publications
2 Lansing Square, #703
Willowdale, ONT M2J 4P8
Tel: (416) 497-9562
Attn.: Sharon Raspin

IN U.K.

JCT International Ltd.
Hanover Court
5 Hanover Square
London WIR 9 HE
Tel: 01-499-6827
Attn.: Gordon MacFarland

IN NETHERLANDS

Nippon Express (Nederland) B.V.
Postbox 7175
1007 JD Amsterdam
Tel: 020-621387
Attn.: Errol Lafleur

CIRCLE NO 87

It Thinks in Real Time

SOLTEC's Signal Processor gives you results as they happen.

Now you can have results as they happen—all in real time—with integrated permanent hard copy plus simultaneous digital output. No longer is it necesssary to waste valuable time performing manual calculations.

The 500SP provides real time signal processing using 19 microprocessors and 300 KBytes of RAM and ROM while utilizing a multi-channel processor with priority control.

This sophisticated microprocessor design allows the user to selectively link independent channels, functions, and servos for maximum performance and versatility. Analog or digital inputs can be processed and output in user defined units to the digital servo recorder or to one of its standard output interfaces.

The 500SP has been designed to accommodate 8 independent signal processing modules. Each module has its own A/D converter and microprocessor, plus its own programmable digital filter, automatic range, and calibration control.

Additionally, the 500SP offers IEEE-488 and RS-232 interfaces, a real time clock, and menu save. It also annotates in alphanumeric characters and records time, date, trigger and alarm situations.

Have it all in no time—Have it in real time. Best of all, you can have it now. Call 1-800-423-2344 or (818) 767-0044 in California. Or write
SOLTEC CORPORATION
Sol Vista Park, San Fernando,
CA 91340 for information.

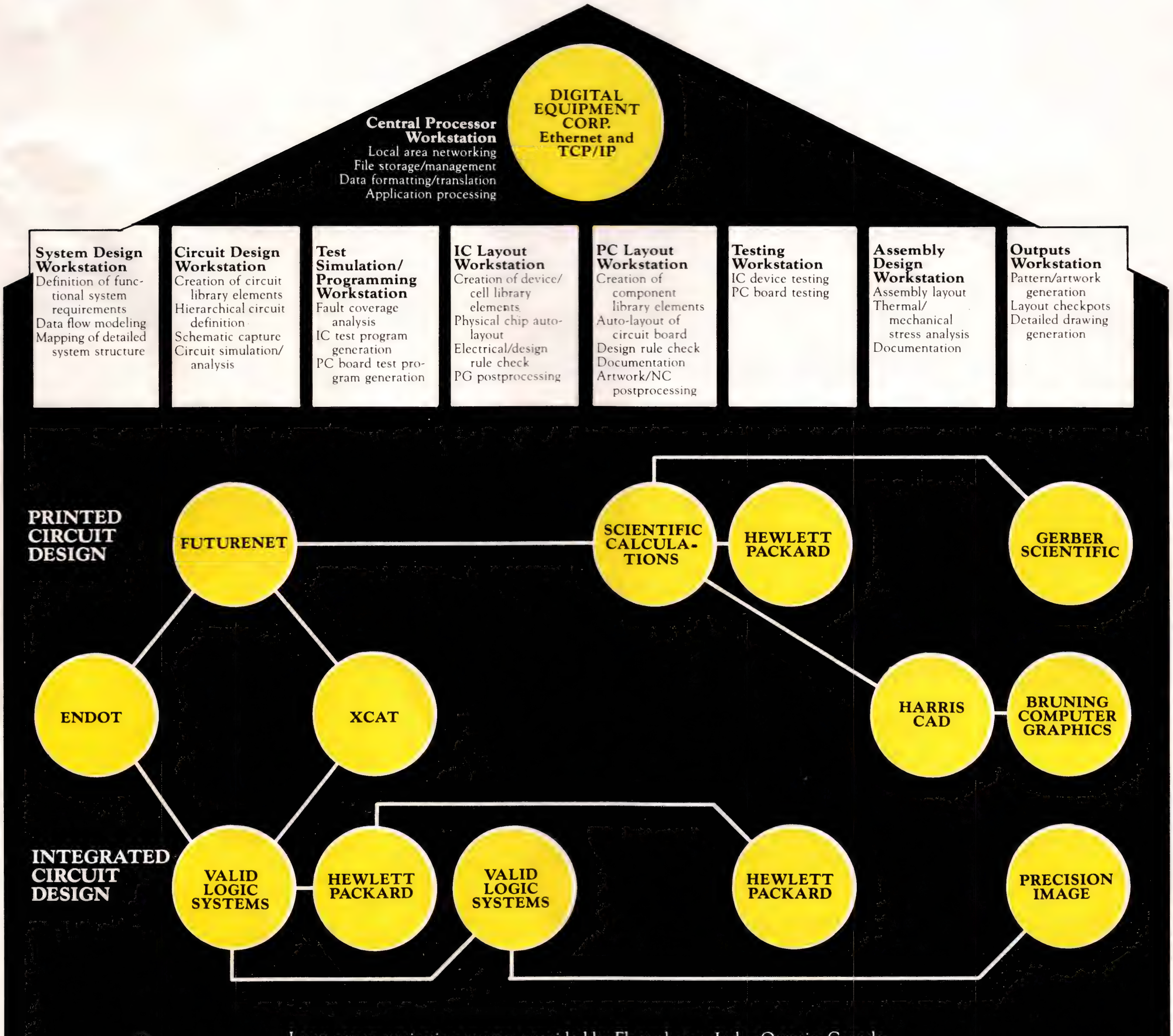
SOLTEC®

CIRCLE NO 86

Using the CAE and CAD design tools of a variety of companies —just as you would, if you could, in your workplace— we've made the links, set-up the interfaces necessary for a complete, end-to-end circuit and systems design

CIRCUITPATH

Data Flow Chart



DIGITAL EQUIPMENT CORP.
Ethernet and TCP/IP

Central Processor Workstation
Local area networking
File storage/management
Data formatting/translation
Application processing

System Design Workstation
Definition of functional system requirements
Data flow modeling
Mapping of detailed system structure

Circuit Design Workstation
Creation of circuit library elements
Hierarchical circuit definition
Schematic capture
Circuit simulation/analysis

Test Simulation/Programming Workstation
Fault coverage analysis
IC test program generation
PC board test program generation

IC Layout Workstation
Creation of device/cell library elements
Physical chip auto-layout
Electrical/design rule check
PG postprocessing

PC Layout Workstation
Creation of component library elements
Auto-layout of circuit board
Design rule check
Documentation
Artwork/NC postprocessing

Testing Workstation
IC device testing
PC board testing

Assembly Design Workstation
Assembly layout
Thermal/mechanical stress analysis
Documentation

Outputs Workstation
Pattern/artwork generation
Layout checkpots
Detailed drawing generation

Large-screen projection systems provided by Electrohome, Ltd.—Ontario, Canada

Come, see, question and discuss at...

Automated Design and Engineering for Electronics West

March 31-April 2, 1987
Anaheim Convention Center
North Hall
Anaheim, California
Exhibit Hours: 8:00 a.m.-5:00 p.m. Tues. & Wed.
8:00 a.m.-4:00 p.m. Thurs.

Sponsored by:
EDN

Endorsed by:
Electronic Business
Electronic Packaging and Production
Design News
Semiconductor International

CEG® A Member of: THE REED EXHIBITION COMPANIES

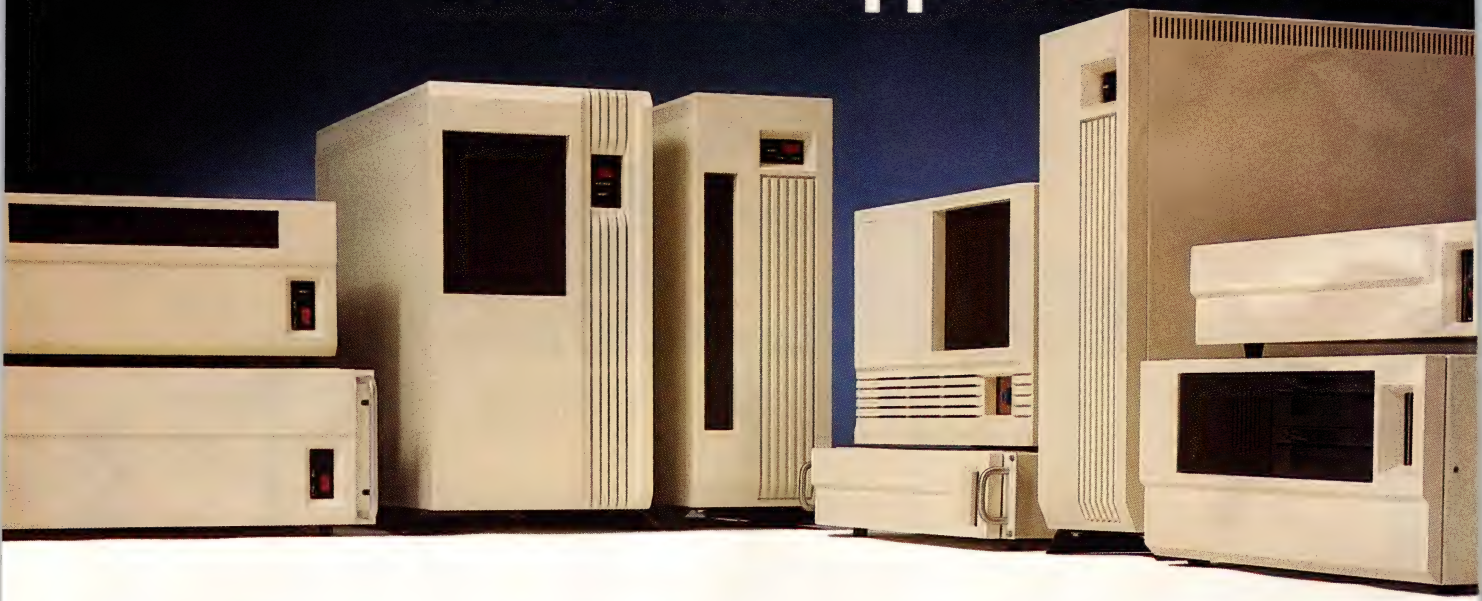
Cahners Exposition Group
1350 E. Touhy Ave.
P.O. Box 5060
Des Plaines, Illinois 60017-5060
Phone: (312) 299-9311
Telex 256148 CEGCGO DSP

©1987 Reed Holdings, Inc.

A8

BRING THIS AD TO THE DOOR FOR FREE ADMISSION TO CIRCUITPATH AND THE EXHIBITS

VME, Multibus and Multibus II: Package Your System to Win World-Wide Approval



If you sell systems anywhere, you face an increasing number of safety and performance standards. Tough design specs that cost plenty to meet and cost plenty to prove you meet them.

So package your system in an Electronic Solutions enclosure. One that has already met these standards:

Recognized by Underwriters Laboratories, Inc.

FCC
Federal Communications Commission

BAUART GEPRÜFT
TUV Rheinland (VDE equivalent)

Canadian Standards Association

IEC380
International Electrotechnical Commission

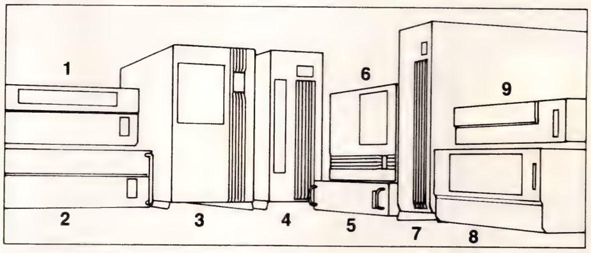
—plus FCC Part 15 Class A EMI/RFI compliance that most VME or Multibus II card racks miss by a wide margin.

All you need to add are the cards.

Choose from a huge selection of attractive tabletop, rack-mount and floor-standing DeskMate enclosures with 3,4,5,7,10,11,12,13 or 15 card slots. In sizes from only 3½″ high. Choose from many options: front, rear, or top card loading; mounting of up to eight half-height 5¼″ peripherals; P1 and P2 backplane configurations; and power supply capacity up to 500 Watts.

So to help build your reputation take a little of ours. Our reputation for strength, ruggedness, reliability—and, of course, appearance.

To find an enclosure that meets your approval, call us today for complete catalogs on VME, Multibus and Multibus II System Packaging.



1. Series 7 with 2 half-height peripherals
   5 slots VME, Multibus II; 7 slots Multibus I
2. Series 7 (shown with rack mounting)
   7 slots VME, Multibus II; 10 slots Multibus I
3. Series 10 DeskMate with 4 full- /8 half-height peripherals
   12 slots VME; 10 slots Multibus II; 15 slots Multibus I
4. Series 7 DeskMate
   5 slots VME, Multibus II; 7 slots Multibus I
5. Series 3 (shown with rack mounting)
   3 slots VME, Multibus II; 4 slots Multibus I
6. Series 10 with 4 full- /8 half-height peripherals
   12 slots VME; 10 slots Multibus II; 15 slots Multibus I
7. Series 7 DeskMate
   7 slots VME, Multibus II; 10 slots Multibus I
8. Series 7 with 2 full- /4 half-height peripherals
   7 slots, VME, Multibus II; 10 slots Multibus I
9. Series 3
   3 slots VME, Multibus II; 4 slots Multibus I

THREE YEAR 3 LIMITED WARRANTY

ZERO **Electronic Solutions**
UNIT OF ZERO CORPORATION

6790 Flanders Drive, San Diego, CA 92121 • (619) 452-9333 TLX: 910-335-1169
Call Toll Free: (800) 854-7086 In Calif: **(800) 772-7086**

CIRCLE NO 143

An 80386 μP and two operating systems enhance PC-compatible CAE workstation

CAE applications run two to three times as fast on the Personal Logician 386 as they do on the vendor's IBM PC/AT-based Personal Logician 286. As their names imply, the Personal Logician 286 uses Intel's 80286 μP in its CPU; the Personal Logician 386 uses the 80386 μP.

Although the Personal Logician 386 runs faster than a PC/AT, the 80386-based system provides PC compatibility. The workstation uses the IBM PC/AT bus and runs MS-DOS.

The system includes a 16-MHz 80386 μP; 2.5M bytes of RAM; a 44M-byte hard-disk drive; an 80287 coprocessor; Enhanced Graphics Adapter (EGA) graphics; and a 13-in., 640×350-pixel monitor. To improve your display, you can add either a 15-in. or a 19-in. color monitor to the Personal Logician 386. The optional monitors both spec 1024×824-pixel resolution.

The Personal Logician 386 isn't just a faster PC—it also runs the company's CAE and CAD software. Further, you can connect design-automation hardware, such as the PMX hardware modeler, to the personal computer.

Because MS-DOS can address only 640k bytes of memory, the company's CAE and CAD software doesn't run under MS-DOS. Instead, the design-automation programs run under the DNIX operating system, which is the company's implementation of Unix. This multitasking operating system features multiple display windows, expandable memory, and virtual memory.

The standard DNIX package includes a schematic editor, a design compiler, a text editor, and a net-list extraction program. You can add logic simulation, analog simulation, and test analysis to the package. Other software available for the workstation includes layout tools for gate arrays, pc boards, and custom ICs. Note, however, that the 386-based PC can't run all of the company's software. You must transfer IC-layout-verification and pc-board-routing tasks to a DEC VAX or to the company's Logician computer.

The Logician, which also now includes an 80386 μP, runs all of the company's CAE and CAD programs, but doesn't run MS-DOS software. The Logician features design and layout software; a 19-in., 1024×832-pixel color monitor; a graphics controller; 85M bytes of hard-disk memory; and 4M bytes of RAM. You can expand the RAM to 16M bytes and the hard-disk memory to 1.2G bytes. Including IC-layout software, the Logician 386 costs $85,000. The Personal Logician starts at $20,000.—***Eva Freeman***

Daisy Systems Corp, Box 7006, Mountain View, CA 94039. Phone (415) 960-0123. TLX 858262.

Circle No 729

To increase the speed of programs running under the DNIX and MS-DOS operating systems, *the Personal Logician 386 incorporates an 80386 μP. Electronic-design applications run on the workstation under DNIX; all other programs, including office-automation software, run on the system under MS-DOS.*

Single-chip data-acquisition system performs many of the tasks of a µP

The ML2200 low-power CMOS chip includes a 13-bit A/D converter (12 bits plus sign), a 4-channel differential multiplexer, a programmable-gain instrumentation amplifier, an S/H amplifier, a voltage reference, and a digital-control section that can perform many data-acquisition tasks.

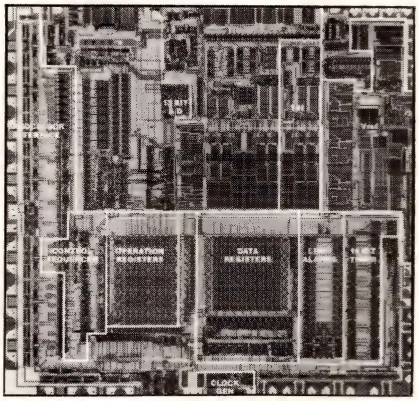
The 13-bit A/D converter is a self-calibrating design that doesn't require any external trimming devices. It converts 13 bits at 40 kHz max and eight bits at 50 kHz max. At a 13-bit resolution, the converter's integral and differential nonlinearity spec of ±½ LSB is guaranteed over temperature, power-supply range, and product aging.

Each of the four inputs is differential, providing high noise immunity. Any one of the channels can be used as a reference for an A/D conversion, so you can perform ratiometric measurements.

The programmable gain amplifier (PGA) is inherent in the A/D-conversion scheme. It allows a gain of 1, 2, 4, or 8. The instrumentation-amplifier offsets are nulled to less than ¼ LSB prior to the start of sampling.

The internal bandgap reference is accurate to 2.5V±2 mV. The temperature coefficient of the reference is 50 ppm/°C from 0 to 70°C. The reference also includes an output that is directly proportional to the temperature of the chip.

The digital-control section consists of a programmable sequencer, a double 8-word buffer, limit alarms, a 16-bit counter, and a µP interface. The ML2200 can easily handle certain tasks that are normally handled by the µP, so it can offload the µP of much of the overhead associated with data acquisition.



Because its 13-bit A/D converter takes up very little real estate, *the entire ML2200 can exist on a single chip.*

When initializing the system, the µP programs the sequencer by loading the on-chip instruction RAM and control registers. The 8-step sequencer contains eight words of 16 bits each. Each word is divided into seven different fields: reference selection, gain, 8- or 13-bit conversion, channel number, trigger source, limit-alarm activation, and an indicator that shows whether an operation is the last one in the sequence.

To see how the chip can benefit your system applications, consider a system with four sensors, each having different gain requirements. Three of the sensors are used as variables in a calculation for control of the system. The fourth sensor must be monitored continuously; if the measured value exceeds its preset limits, the system must shut down quickly.

In a conventional A/D system, the µP has to set the multiplexer, set the gain, start the conversion, and read the result for each channel. When the alarm channel is acquired, the value must be compared to a maximum value. If the maximum has been exceeded, the µP must execute the shutdown procedure.

In a similar system that uses an ML2200, however, the µP only needs to initialize the ML2200 and read the acquired data from the data buffer. If the alarm channel exceeds the preset limit, an interrupt can be generated, so the µP can handle the alarm condition quickly. The reduction in µP overhead is considerable, and the system using the ML2200 responds to the alarm condition much more quickly than would a system using the conventional approach.

The ML2200 Exerciser can aid you in using and understanding the ML2200. The Exerciser is an ML2200 on a pc board that interfaces to an IBM PC. This development system allows full access to all of the ML2200's registers and provides full-speed operation and full data-capture facilities. The software included in the package provides the means to control the ML2200. It allows you to store acquired data in a 20k-word buffer and to display the data either graphically or in table form.

The ML2200 costs $60 (1000). Samples are available now; the manufacturer expects to begin production in the third quarter of 1987.

— David Shear

Micro Linear, 2092 Concourse Dr, San Jose, CA 95131. Phone (408) 262-2095. TLX 275906.

Circle No 725

ZILOG

SUPER8

The most powerful, cost-effective single-chip MCU anywhere.

The Super8™ family of 8-bit MCUs gives you higher performance than a lot of 16-bit processors… and opens the door to a whole new realm of single-chip designs.

Super 20MHz speed.

No other 8-bit MCU comes close to the 20MHz Super8. You'll always have plenty of performance to accomplish your software tasks – with CPU time to spare.

Super ROM memory.

Memory's no problem either, with up to 16K of internal ROM, up to 128K of external RAM or ROM, and 325 registers – 272 general-purpose – with dual register pointers for fast register access and context switching.

Super-fast 600-nanosecond interrupt mode.

The Super8 offers you 40 interrupt sources and 600-nanosecond response time to each of the 8 priority levels – the fastest reaction time in the single-chip MCU world.

Super bottom line.

The Super8 gives you all this unmatched performance – and a whole lot more. Off the shelf. Backed by Zilog's proven quality and reliability. At a price that leaves the competition even further behind. Contact your local Zilog sales office or your authorized distributor today. It's time to see how "super" your designs really can be.

	Super8	**8096**	**8052**
Architecture	8-bit	16-bit	8-bit
Technology	NMOS	NMOS	NMOS
Clock	20MHz	12MHz	12MHz
Program Memory	0, 8, 16K ROM	0, 8K ROM	0, 8K ROM
Registers	272 byte general-purpose, 53 mode/control	230 byte general-purpose, 26 mode/control	32 byte general-purpose, 26 mode/control, 224 Indirect RAM
External Memory	up to 128K of RAM or ROM	up to 64K of RAM or ROM	up to 64K of RAM or ROM
DMA	Single-channel with 16-bit pointer and count register	None	None
I/O Lines	40 programmable with 2 handshake channels	26 programmable 12 fixed input 2 fixed output	32 programmable
Counter/Timers	3 16-bit: 2 up/down-count with bivalue and capture modes, 1 down count only	2 16-bit up-count only with 4 high-speed input units	3 16-bit up-count only
Serial I/O	1 full-duplex UART with special modes, up to 2.5 Mb/s	1 full-duplex UART up to 0.2 Mb/s	1 full-duplex UART, up to 1.0 Mb/s, 1-bit bus
Interrupts	40 sources, 16 vectors, 8 programmable priority levels, minimum response 0.6 microsecond	8 sources, 8 vectors, minimum response 15 microseconds	6 sources, 8 vectors, minimum response 6 microseconds
Min. Execution	0.6 microsecond at 20MHz	1 microsecond at 12MHz	1 microsecond at 12MHz
Price (100)	$4.95	$24.75	$7.60

The choice is clear.

Right product. Right price. Right away.

ZILOG SALES OFFICES: CA (408) 370-8120, (714) 432-9971, (818) 707-2160, **CO** (303) 494-2905, **FL** (813) 585-2533, **GA** (404) 451-8425, **IL** (312) 885-8080, **MA** (617) 273-4222, **MN** (612) 831-7611, **NJ** (201) 288-3737, (609) 778-8070, **OH** (216) 447-1480, **TX** (214) 231-9090, **CANADA** Toronto (416) 673-0634, **ENGLAND** Berkshire (44) (628) 39200, **W. GERM.** Munich (49) (89) 612-6046, **JAPAN** Tokyo (81) (3) 587-0528, **HONG KONG** Kowloon (852) (3) 723-8979. **U.S. AND CANADA DISTRIBUTORS:** Hall-Mark Elec., Schweber Elec., Western Microtech., Anthem Elec., JAN Devices, Inc., Bell Indus., Lionex Corp., Graham Elec., Alliance Elec., **CANADA** SEMAD, Future Elec.

Zilog
an affiliate of
EXXON Corporation

PC-board-manufacturing workstation integrates design, test, and fabrication

By transmitting the pc-board layout of a design to the CDX-60000S manufacturing workstation, you can adapt your design to fit your production requirements. Instead of stepping and repeating a photoplot, you step and repeat a layout on the workstation's screen.

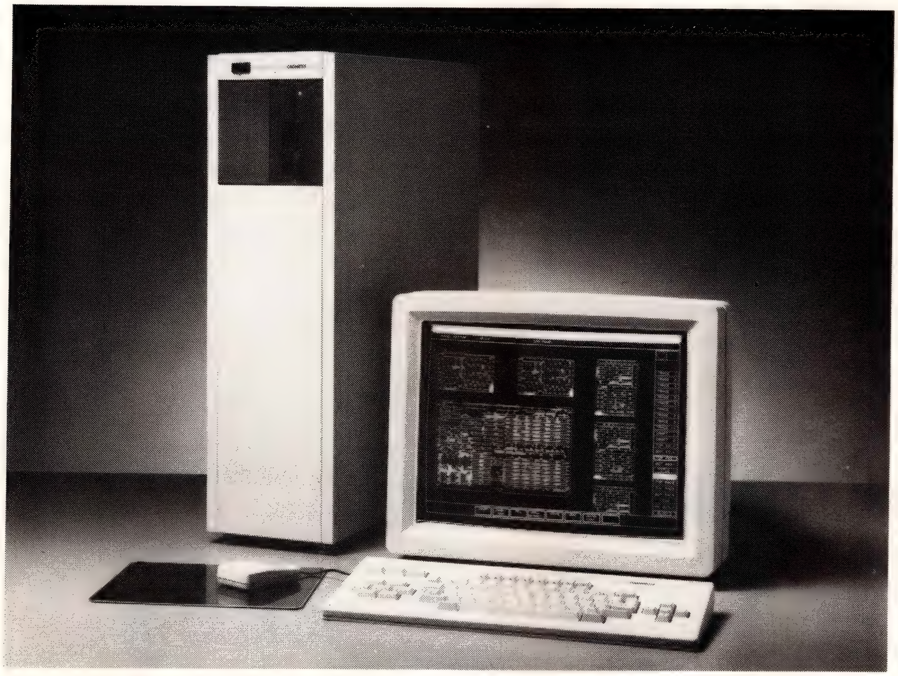
Because pc-board manufacturers make boards in large panels, which contain many copies of one board, you can't use just one copy of a layout for production. You must step and repeat the layout across the panel.

If all production equipment were perfect, stepping and repeating a photoplot would produce perfect pc boards. But stepping and repeating a photoplot requires accurate registration on all layers of a board. Furthermore, you can't make a photoplot compensate for the etching peculiarities of individual manufacturing systems.

The workstation's ability to process net-list data also lets it develop test vectors for production tests. Bare-board testers can use the files in the manufacturing workstation to simulate a complete panel.

When you're designing and assembling your boards at different sites, you can use the workstation's database to generate assembly instructions. The system also creates complete bills of materials for panels.

The CDX-60000S workstation improves the fabrication yield of pc boards because it lets you change manufacturing parameters interactively. You can, for example, shave pads, change trace widths, alter pad sizes, adjust drill-hole sizes, or add copper areas. The system has as many as 24 trace layers, 24 drafting layers, and 12 layers for silkscreen and outlines, so you can produce boards of any complexity.



This screen shot combines two pc-board layouts. *The CDX-60000S has placed one large design and several copies of a smaller design on a single panel.*

The manufacturing workstation can write fabrication instructions for most production equipment, such as photoplotters, N/C drillers, profile routers, autoinsertion tools, and pick-and-place systems. If the manufacturing workstation can't write an instruction set for a particular fabrication system, you can use the workstation's database query language to create an instruction file for that system. Using the database query language, you can specify drill, shape, pad, via, insertion, and test instructions. The workstation can then convert the instructions to any format.

You can enter design data from the vendor's CAD workstations or from Racal-Redac (Westford, MA), Scientific Calculations (Fishers, NY), and Computervision (Bedford, MA) systems. You can also enter photoplotter data, although you can't derive a net list from the graphical data that a photoplotter uses.

The CDX-60000S manufacturing workstation is a 68020-based color workstation. The system comes with 8M bytes of RAM (which you can increase to 12M bytes), the database query language, an asynchronous communications link, and a set of standard design postprocessors. $119,900.—***Eva Freeman***

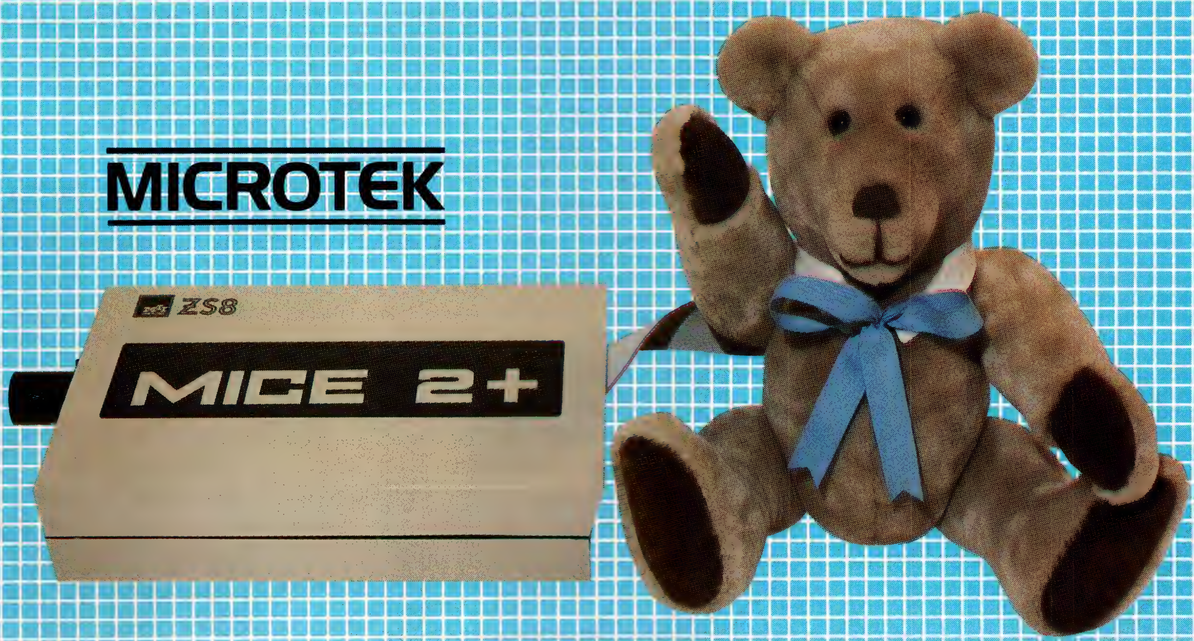
Cadnetix Corp, 5757 Central Ave, Boulder, CO 80301. Phone (303) 444-8075.

Circle No 730

(TEDDY TELLS ALL)

"WITHOUT THE MICROTEK MICE 2+, I MIGHT HAVE BECOME A FRANKENSTEIN INSTEAD..."

MICROTEK



Design time is critical. It can become an uncontrolled monster if allowed to continue unchecked. Bringing today's innovative electronic products and systems to market ahead of competition demands precise time-saving efficient development and debugging tools.

Look to Microtek for a powerful line of micro in-circuit emulators and software tools to assure rapid product development and shortened design-to-market cycles. Microtek emulators fully support most popular processors and micro controllers.

The bear loudly proclaims, "the MICE 2+ helped speed *my* creation — I can't bear to think that I might have become a monster instead of my lovable, talkative self.

"Grandpa Teddy was right, speak loudly and carry a small chip."

Call New Micro for complete information and technical support. New Micro is the exclusive sales, service and marketing organization for Microtek in-circuit emulators.

Other processors supported by Microtek: 80386, 80286, 80186, 80188, 8086, 8088, 68000, 68010, 68008, Z80, NSC800, 8085, 6809, 6809E, 6502 (40 and 28 PIN) 8032, 8051, 8031, 8344, 8048, 8049, 8050, Z8, SUPER 8

NMI

New Micro, Inc.
16901 So. Western Ave.
Gardena, CA 90247
1-800-233-6048
In CA: (213) 538-5369

Micro Interfaces (S. East)
1-800-637-7226
In FL: (305) 623-9262

NMI is a Microtek company

ARGENTINA Microtec Ingenieria S.R.L. 54 (1) 46-8749/45-1934 • **AUSTRALIA** Macro Dynamics PTY LTD. 61 (03) 2207260 • **AUSTRIA** Allmos Electronic GMBH 43 (222) 627 19 54 • **BELGIUM** Simac Electronics B. V. 32 (02) 219 24 53 • **BRAZIL** Digibyte Sistemas Digitals LTDA 55 (011) 241-3611 • **CANADA** Tracan Electronics Corp 1 (416) 625-7752 • **CHILE** Equipos Industriales S.A.C.I. 56 (2) 382942 • **DENMARK** Metric A/S 45 (02) 80 42 00 • **FINLAND** Nurmikro KY 358 (0) 204981 • **FRANCE** Technologie Electronique 33 (1) 823. 15. 24 • **HONG KONG** Chai Luk Computer LTD. 852 (5) 751151/752172 • **HONG KONG** Idealand Electronics LTD. 852 (3) 7443516-9 • **ISRAEL** Aritmor 972 (03) 727317 • **ITALY** Pratica S.R.L. 39 (011) 50. 34. 27 • **ITALY** (Educational Market Only) Tekno Scuola SRL 39 (085) 693510 • **NETHERLANDS** Simac Electronics B.V. 31 (040) 533725 • **SINGAPORE** EPE Computronics PTE LTD. 65 7468182 • **SPAIN** Novatronic S.A. 34 (4) 4520811 • **SWEDEN** Nordisk Arrayteknik AB 46 (08) 7349935 • **SWITZERLAND** Traco Electronic AG 41 (01) 201 07 11 • **UNITED KINGDOM** ARS Microsystems LTD. 44 (0276) 685005 • **WEST GERMANY** Allmos Electronic 49 (089) 8572086-89 •

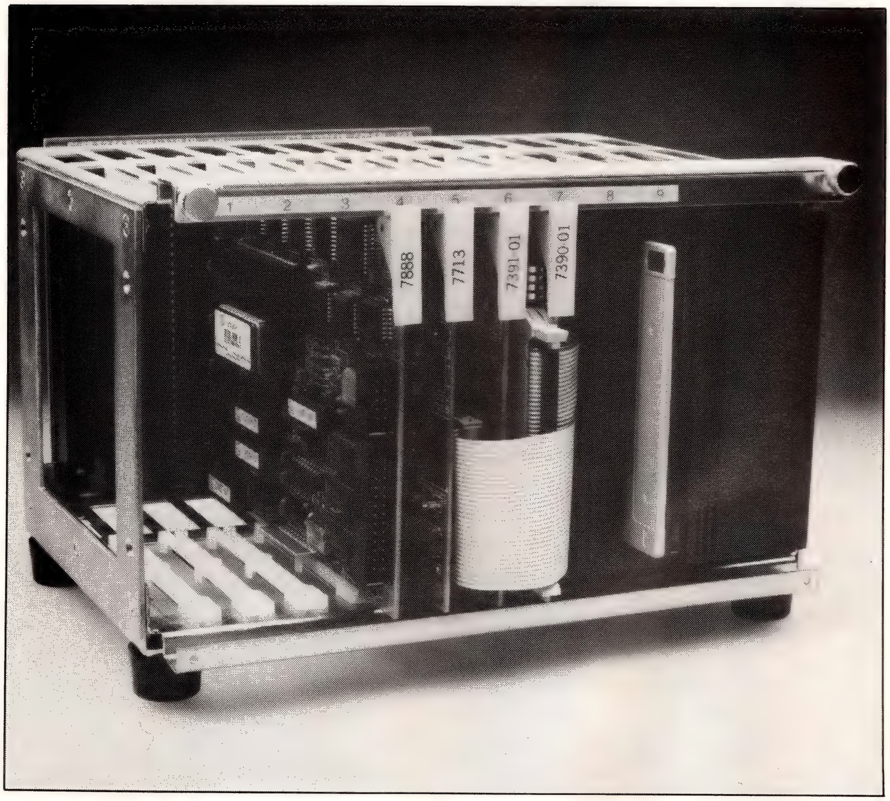
CIRCLE NO 142

STD Bus-based IBM PC-compatible system suits industrial automation applications

The STD Bus-based System 2 offers IBM PC compatibility at the operating system, BIOS (basic I/O system), and chip-hardware levels. The system, which runs MS-DOS version 3.2, is as compatible with the IBM PC/XT software environment as are most non-IBM systems based on the IBM PC bus, yet it's rugged enough for use on the factory floor.

To provide extensive hardware/software compatibility with the IBM PC/XT, the System 2 employs a serial port implemented with an 8250 UART. Some communication software written for the IBM PC will work only with an 8250 UART or an exact compatible. Because the System 2 incorporates an 8250, therefore, it can operate all IBM PC-compatible communication software, external modems, serial-port mice, and other items.

The System 2 doesn't accept IBM PC plug-in cards, but you can choose from a variety of STD Bus cards. For example, you can buy the optional Model 7350 graphics/keyboard card. The card provides IBM PC-compatible CGA (color graphics adapter), EGA (enhanced graphics adapter), and monochrome operating modes, and it interfaces to the standard IBM PC keyboard. You can also choose from the myriad cards offered by STD Bus card vendors for industrial and factory automation.



Providing operating-system, BIOS, and chip-hardware-level compatibility *with the IBM PC/XT, the System 2 STD Bus-based computer runs almost all IBM PC/XT-compatible application software. The computer also accepts a card that emulates the IBM PC CGA, EGA, and monochrome display-adapter cards.*

In terms of ruggedness and reliability, the STD Bus offers several advantages over the IBM PC bus. For example, STD Bus cards are smaller, and when they're in a card cage, they're mechanically supported on three sides.

The System 2 operates from 0 to 60°C and withstands 10g shock. It offers an MTBF rate of more than 5 years at 55°C, and the manufacturer provides a 5-year parts and labor warranty.

You can purchase the System 2 in two configurations. Model 10 includes 128k bytes of CMOS static RAM and two semiconductor disk drives. Model 20 substitutes a 3½-in. floppy-disk drive for the semiconductor disk drives. Both models have 128k bytes of CMOS static RAM that's expandable to 640k bytes. You can add an additional floppy-disk drive or 20M-byte Winchester drive to both models. The systems employ an NEC V20 μP and include a clock/calendar chip.

For software support, you can purchase the vendor's STD-LIB 2.0 software library. The library provides initialization and driver routines for 22 STD Bus cards. The routines link to programs written in Microsoft C, Basic, or assembler languages. Other optional packages include software for prototyping and communications. Model 10 costs $1195, and Model 20 sells for $1595. The 7350 graphics/keyboard card is $565.—***Maury Wright***

Pro-Log Corp, 2560 Garden Rd, Monterey, CA 93940. Phone (408) 372-4593. TWX 910-360-7082.

Circle No 731

FREE!

ORDER NOW

ALLIED ELECTRONICS INC.
A SUBSIDIARY OF HALL-MARK ELECTRONICS CORP.
Customer Service Information, Branch Locations 1
Batteries, Circuit Breakers and Fuses 2
Cabinets, Enclosures, Fans and Motors 3
Capacitors and RFI Filters 4
Communication Equipment (Headsets) 5
Connectors, Sockets, Terminal Blocks and Plugs 6
Hardware, Knobs, Chemicals 7
LEDs, Indicator Lamps, Displays, Tubes and Optoelectronics 8
PA Equipment, Intercoms, Audio 9
Printed Circuit Boards and Accessories 10
Potentiometers, Resistors, Dials 11
Power Conditioners, Power Supplies, Outlet Boxes 12
Relays and Solenoids 13
Semiconductors, Discretes, and Selection Guide 14
Soldering Equipment and Tools 15
Switches, Timers and Controls 16
Test Equipment and Panel Meters 17
Transformers 18
Wire, Cable, Shrink Tubing and Wire Accessories 19
Product and Manufacturer Index 20
5.20
1987 Engineering Manual & Purchasing Guide

THE ALL NEW 1987 ALLIED ENGINEERING MANUAL & PURCHASING GUIDE.

Expanded inventory, new manufacturer offerings and on-time delivery of quality products can now be yours through your old friends at Allied.

We've become partners with Hall-Mark Electronics Corp., giving us the financial strength to implement programs designed to support your product needs with the kind of reliable service you deserve.

Return to dependability. Return to Allied. We're in the book. In fact, we are the book.

Allied. We're back.

CIRCLE NO 138

ALLIED ELECTRONICS INC.

A SUBSIDIARY OF HALL-MARK ELECTRONICS CORP.

Order your FREE 1987 Allied catalog. Fill out this coupon and send to:
Allied Electronics, 401 E. 8th Street, Fort Worth, TX 76102.

Name ____________________

Company ____________________

Title ____________________

Address ____________________

City ____________________ State ____________ Zip ____________

Phone ____________________

EDN031887

WHY YOUR COMPUTER NEEDS A DOG...

If a dog is man's best friend, this watchdog may very well be a computer's best friend. Dallas Semiconductor has collared an idea that every computer system needs. For the first time, a single chip can monitor the vital signs of a microprocessor-based system, acting as a watchdog for a system malfunction. Dallas Semiconductor's DS1232 MicroMonitor electrically observes the microprocessor's power supply, software execution and external override push-button. When deviant behavior is sensed, the DS1232 shuts down the microprocessor and snaps it back into correct operation.

BARKS WHEN POWER FAILS To monitor the power supply, an on-chip precision reference is compared to Vcc. When Vcc is below a programmable -5% or -10% criteria, power failure is assumed and the microprocessor is reset until the power returns.

WATCHES SOFTWARE ROUTINES. A watchdog timer monitors the software for routine behavior. If the MicroMonitor is not alerted within a prescribed length of time, it assumes the processor is out of control and mandates a restart.

FETCHES ON COMMAND The DS1232 monitors the processor's vital signs independently of human intervention. However, it can be connected to an external push-button for operator initiated restart.

CHASES DISCRETES With the MicroMonitor, the customary RC Network and logic required for processor shutdown and restart are no longer needed. ◆ If you think your computer system could use a watchdog for a companion, then give us a whistle!

CIRCLE NO 141

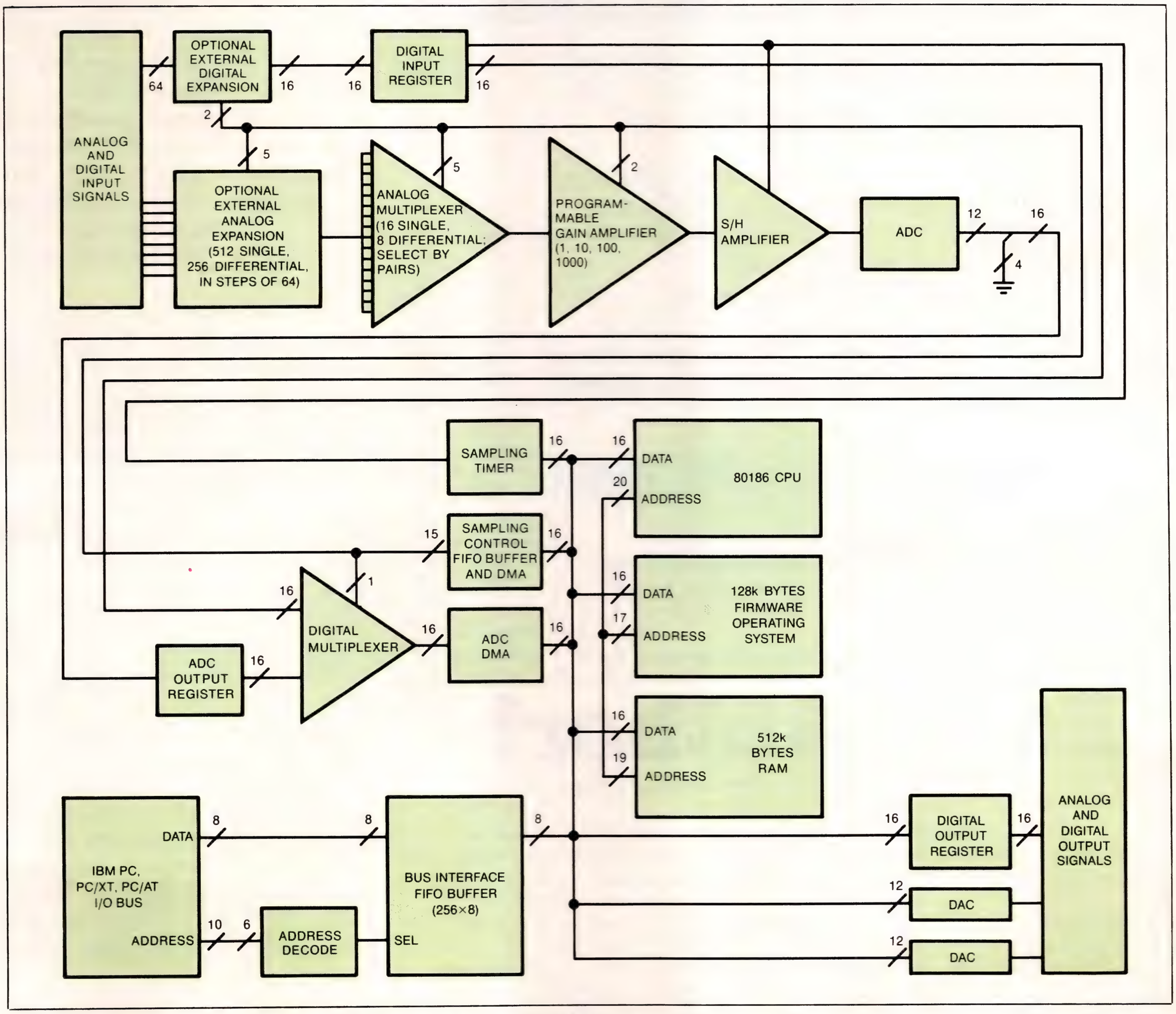
DALLAS SEMICONDUCTOR • 4350 BELTWOOD PARKWAY • DALLAS, TX 75244 • 214-450-0400

INTERNATIONAL DISTRIBUTORS: ALFATRON, AUSTRALIA ◆ BETEA, BELGIUM ◆ REA, FRANCE ◆ TEKELEC, FRANCE ◆ CET, HONG KONG ◆ MALHAR, INDIA ◆ STG, ISRAEL ◆ COMPREL, ITALY ◆ TEKELEC, ITALY ◆ SYSTEMS MARKETING, JAPAN ◆ DYNAMAR, MALAYSIA ◆ DIGICONTROLE, PORTUGAL ◆ INTEGERAD ELEKTRONIK, SCANDINAVIA ◆ PROMILECT, SOUTH AFRICA ◆ VINE OVERSEAS TRADING, SOUTH KOREA ◆ COMELTA, SPAIN ◆ KONTRON, SWITZERLAND ◆ LANDCOL, TAIWAN ◆ JOSEPH ELECTRONICS, UNITED KINGDOM ◆ ATLANTIK, WEST GERMANY

80186-based data-acquisition board provides onboard signal processing

The DAP 1200 board can digitize and process analog signals in real time prior to passing them to a host IBM PC or compatible computer for storage or additional processing. Nonintelligent data-acquisition boards that pass large quantities of unrefined data to the host can exceed both the host's real-time processing capability and its storage capability. For example, acquiring 12 bits of data at 156 kHz for 64 sec will fill a 20M-byte disk. But because the DAP 1200 has an onboard 80186 coprocessor, it lets you perform calculations such as FFTs, cross-correlations, and signal averaging on the data before it goes to the host, so you can pass only reduced data to the host.

In addition, the coprocessor also supports both hardware and software triggering. Triggers are special events, observed or computed from acquired data, that signal the coprocessor when to begin processing. You use triggers to select


ANALOG AND DIGITAL INPUT SIGNALS
64
OPTIONAL EXTERNAL DIGITAL EXPANSION
16
16
DIGITAL INPUT REGISTER
16
2
5
OPTIONAL EXTERNAL ANALOG EXPANSION (512 SINGLE, 256 DIFFERENTIAL, IN STEPS OF 64)
5
ANALOG MULTIPLEXER (16 SINGLE, 8 DIFFERENTIAL; SELECT BY PAIRS)
2
PROGRAM-MABLE GAIN AMPLIFIER (1, 10, 100, 1000)
S/H AMPLIFIER
ADC
12
16
4
SAMPLING TIMER
16
16
DATA
80186 CPU
20
ADDRESS
15
SAMPLING CONTROL FIFO BUFFER AND DMA
16
1
16
DIGITAL MULTIPLEXER
16
ADC DMA
16
16
DATA
128k BYTES FIRMWARE OPERATING SYSTEM
17
ADDRESS
ADC OUTPUT REGISTER
16
16
DATA
512k BYTES RAM
19
ADDRESS
IBM PC, PC/XT, PC/AT I/O BUS
DATA
8
8
8
ADDRESS
10
6
ADDRESS DECODE
BUS INTERFACE FIFO BUFFER (256×8)
SEL
16
DIGITAL OUTPUT REGISTER
16
ANALOG AND DIGITAL OUTPUT SIGNALS
12
DAC
12
DAC

The ROM-resident multitasking operating system *of the DAP 1200/4 data-acquisition board allows tasks to communicate through Unix-like pipes. The board features 12-bit A/D conversion at rates as high as 156k samples/sec.*

the data that the board will process. Because the DAP 1200 buffers data after it's acquired, the board can both pretrigger and posttrigger on events.

The board has a ROM-resident, real-time, multitasking operating system that apportions local resources such as hardware, memory, and data buffers among the various tasks. The tasks communicate by passing data through Unix-like pipes. You configure the operating environment by means of the manufacturer's proprietary high-level language, DAPL.

The DAP 1200 communicates with the host via Basic, C, Pascal, Labtech Notebook, and Lotus 1-2-3. Although the board has predefined data-reduction algorithms such as thermocouple compensation and FFTs, you can also download custom commands from the host. You can configure the programmable digital filter on the board as a lowpass, highpass, bandpass, or notch filter.

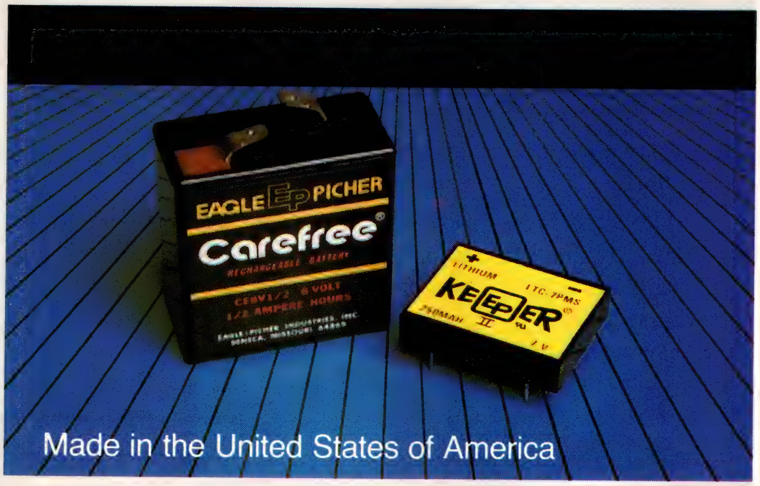
The board features 16 analog inputs (expandable to 512), 16 digital inputs (expandable to 64), 16 digital outputs, and two 12-bit A/D outputs. A programmable gain amplifier offers software-selectable gains. A FIFO buffer allows as many as four DAP 1200s to communicate with the host at DMA speeds while using just one interrupt line.

The board comes in three configurations: the DAP 1200/4 ($1596) has a 10-MHz coprocessor and 512k bytes of RAM, and it performs 156k samples/sec. The DAP 1200/2 ($1276), which has 128k bytes of RAM, and the DAP 1200/3 ($1436), which has 512k bytes of RAM, each have an 8-MHz coprocessor and can sample at 50k samples/sec.

—Margery S Conner

Microstar Laboratories, 2863 152nd Ave NE, Redmond, WA 98052. Phone (206) 881-4286. TWX 510-601-3473.

Circle No 726



Today's Advanced Technology Demands Batteries With A Future

Innovative research and design enables Eagle-Picher to consistently provide highly reliable power sources for today's high-technology products.

The *Carefree®* and *Carefree™ Magnum* series represent the most flexible lines of maintenance-free, rechargeable, sealed, lead-calcium batteries in the world.

The electro chemistry of the *Keeper II® Lithium* series ensures up to 10 years of dependable service in standby applications where long-life memory back-up is required.

EAGLE EP PICHER

Eagle-Picher Industries, Inc.
Box 130 • Bethel Road • Seneca, MO 64865
Phone: (417) 776-2256 • TWX-62864271

Circle 2 for Keeper Battery **Circle 41 for Carefree Battery**
See us at Booth #2182 at the Electro '87 Show

Be An Author!

When you write for EDN, you earn professional recognition. And you earn $75 per published magazine page.

EDN publishes how-to design application information that is read by more than 137,000 electronics engineers and engineering managers worldwide. That's an audience that could belong to you.

If you have an appropriate article idea, please phone Eva Freeman, Associate Editor, at (617) 964-3030, or send a proposal and outline to her at 275 Washington Street, Newton, MA 02158 – 1630. For a FREE EDN Writer's Guide—which includes tips on how to write for EDN and other technical publications—please circle number 800 on the Information Retrieval Service Card.

EDN ***First in Readership among Design Engineers and Engineering Managers in Electronics***

LEADER

NOW Battery Powered!

Choose the New LBO-315 for ac/dc,
or the current LBO-325 for ac only.

LBO-325 CRT is shown actual size.

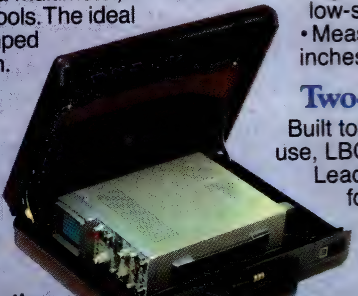
Sometimes it's hard to go back for a scope!

60-MHz full-function field-service Attache Case Oscilloscope is so light and small it will be taken everywhere, every time.

LBO-325 packs all the power and performance of a cumbersome, backbreaking, 60-MHz workbench oscilloscope into an easy-to-carry, ultra-compact, featherweight unit. Although its 3½-inch CRT is as big and clear as screens on large field-service scopes–LBO-325 weighs only 9 lbs. So it won't weigh field-technicians down, no matter how far afield they go! LBO-325 is so small it fits inside a 3-inch deep attache case with room to spare for a multimeter, service manuals and some tools. The ideal full-function scope for a cramped work area or crowded bench.

Reduces the cost of service calls.

Time is money. A scope left in the vehicle takes time to retrieve. One kept in the shop causes repeat service calls. The LBO-325 Attache Case Oscilloscope is so easy to carry and use, techs will take it everywhere, every time. And the time saved translates into extra profits for years to come.



Outperforms all other portables:

• 60 MHz • Dual channel • ALT TIME BASE simultaneously displays main waveform and any expanded portion • ALT TRIG for stable display of 2 asynchronous signals • Bright, sharp 12-kV trace • Large 3½-inch PDA CRT • Illuminated graticule • Comprehensive triggering • TV-V and TV-H sync separators • Variable trigger hold-off • Delay line shows sharp leading edges • CH-1 output drives low-sensitivity instruments • Measures only 3 x 9 x 11⅜ inches • Weighs 9 lbs.

Two-year warranty.

Built tough to provide long use, LBO-325 is backed by Leader's 30-year reputation for reliability and by factory service depots on both coasts.

Circle 42 for product information

Call toll-free
(800) 645-5104
In NY State
(516) 231-6900

Request an evaluation sample, our latest Test Instrument Catalog with over 100 outstanding products, the name and address of your nearest "Select" Leader Distributor, or additional information.

For professionals who know the difference.
LEADER Instruments Corporation

380 Oser Avenue
Hauppauge, New York 11788
Regional Offices: Chicago, Dallas
Los Angeles, Boston, Atlanta
In Canada call Omnitronix Ltd.
(514) 337-9500

Circle 3 for product demonstration

A GIANT LEAP IN DSU/CSU DESIGN BRINGS YOU A SMALLER FOOTPRINT

Large-scale integration has arrived in DSU/CSU design! The result: 54% less volume and a 40% cut in power consumption for Universal Data Systems' latest units. DSU and CSU are combined on a single printed circuit board. Data rates of 56 kbps (CCITT V.35) or 9.6 kbps (RS-232C) are available.

Cards operating at either speed may be specified as free-standing packages or for rack mounting in UDS' RM-16 or comparable multi-channel equipment.

In rack-mounted applications, the DSU/CSU card may be intermixed with conventional modems to achieve the total system performance required.

UDS gives you a footprint so small you can practically tiptoe into DDS. For technical details and quantity prices, contact Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805.
Telephone 205/721-8000;
Telex 752602 UDS HTV.

NEW!

Universal Data Systems
MOTOROLA INC.
Information Systems Group

UDS modems are offered nationally by leading distributors. Call the nearest UDS office for distributor listings in your area.

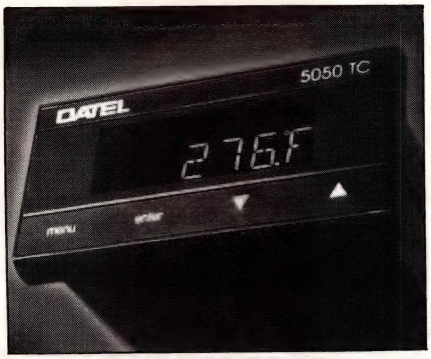
DISTRICT OFFICES: **Apple Valley**, MN, 612/432-2344 • **Atlanta**, GA, 404/998-2715 • **Aurora**, CO, 303/368-9000 • **Blue Bell**, PA, 215/643-2336 • **Boston**, MA, 617/875-8868 • **Columbus**, OH, 614/895-3025 • **East Brunswick**, NJ, 201/238-1515 • **Glenview**, IL, 312/998-8180 • **Houston**, TX, 713/988-5506 • **Huntsville**, AL, 205/721-8000 • **Issaquah**, WA, 206/392-9600 • **Livonia**, MI, 313/522-4750 • **Mesa**, AZ, 602/820-6611 • **Milwaukee**, WI, 414/273-8743 • **Mission Viejo**, CA, 714/770-4555 • **Mountain View**, CA, 415/969-3323 • **Richardson**, TX, 214/680-0002 • **St. Louis**, MO, 314/434-4919 • **Silver Spring**, MD, 301/942-8558 • **Tampa**, FL, 813/684-0615 • **Uniondale**, NY, 516/222-0918 • **Van Nuys**, CA, 818/891-3282 • **Willowdale**, Ont, Can, 416/495-0008

CIRCLE NO 140

Created by Dayner/Hall, Inc., Winter Park, Florida

Digital meter interfaces directly to thermocouples

The PM-5050 may change the way you think about and use digital panel meters (DPMs). The unit, which fits into a one-eighth-size DIN panel cutout, connects directly to thermocouple types B, E, J, K, N, R, S, and T. The meter's internal circuitry filters, amplifies, and converts the thermocouple's voltage to a direct temperature readout in units of °C or °F. You can choose a resolution of either 1° or 0.1° for the 5-digit display. The meter measures temperatures accurately over the entire ANSI-specified temperature range for each thermocouple type. It also provides cold-junction compensation.



***The PM-5050 digital panel meter displays temperature readings** in °C or °F. The meter connects directly to thermocouples, and it provides internal cold-junction compensation.*

Besides measuring temperature, the meter controls four independent setpoints, each of which activates a MOSFET. Each optically isolated MOSFET switches as much as 100 mA at as much as 300V. The setpoint outputs let you control alarms, heater relays, and other electrical devices. The setpoint switches are individually programmable for temperatures that go either above or below a limit you set. The setpoint hysteresis is selectable in 1° steps from 1° to as much as 25°.

Four front-panel membrane switches let you select options from an extensive menu that scrolls through the meter's alphanumeric display. Menu items let you establish setpoint temperatures, set a hysteresis value, test the meter, and control its RS-232C port. Internal nonvolatile RAM stores the menu selections when the meter is not powered.

The internal RS-232C port lets you connect the meter to a remote computer system. As many as 50 ASCII commands let you remotely control the meter's functions and acquire data from the meter. Because you can set each meter to respond to a 2-digit identification code, as many as 100 meters can connect to one RS-232C port on your computer. The meter provides three levels of security so that people have limited access to the meter's menus from the front panel. However, communications through the unit's RS-232C port give you control over all of the functions at all times.

The meter measures 3.622×1.771×5.47 in. and weighs 567g. Available models operate on 115V, 230V, or 100V ac, or 5V dc. They consume less than 4W under normal operation. Options include an analog output that furnishes either a 4- to 20-mA or a 0 to 10V dc output. You can preset the temperature range that will correspond to the full-scale current or voltage output. The PM-5050 costs $395. The optional analog output costs $65; you must order it with the basic meter.—***Jon Titus***

GE Datel, 11 Cabot Blvd, Mansfield, MA 02048. Phone (617) 339-9341. TLX 951340.

Circle No 732

WORLD'S SMALLEST DIP SWITCH

SAME SIZE AS AN IC

BETTER HEAT CONVECTION.

OLD DIP SWITCH

AIR CONVECTION

HIGH DIPS SHADOW LOW IC'S

NEW DIP SWITCH

AIR CONVECTION

K40

THE LOW PROFILE K40 DIP IS THE SAME SIZE AS AN IC

NO MORE HAND LABOR.

YOU CAN USE AUTOMATIC INSERTION EQUIPMENT!

If you don't have automatic insertion equipment, we're banking that some day you will. To prove that, we'll charge you the same low price for all your purchases—no more need for the low-volume premium prices you're paying now.

AVAILABLE IN 2, 3, 4, 5, 6, 7 & 8 POSITIONS

FREE SAMPLE! WITH STAPLED BUSINESS CARD TO YOUR LETTERHEAD

AMERICAN RESEARCH & ENGINEERING
1500 EXECUTIVE DRIVE
ELGIN, IL 60120
312-888-7245

America can do it better!

CIRCLE NO 22

Interested in Lasers

?

Conference on Lasers and Electro-Optics

concurrent with

International Quantum Electronics Conference

Baltimore, Maryland

Conference:
April 27 - May 1, 1987

Exhibits: April 28-30
(no charge to attend exhibition)

Your professional specialty doesn't matter. If lasers are becoming increasingly important to you in your work, you need more technical information and you need it fast.

Come to the world's largest laser conference and trade show. See exhibits of lasers and related hardware by more than 300 manufacturers and distributors and attend more than 900 technical presentations.

For a copy of the advance program, write or call:

CLEO/IQEC '87
Optical Society of America
1816 Jefferson Place NW
Washington, DC 20036
(202) 223-8130

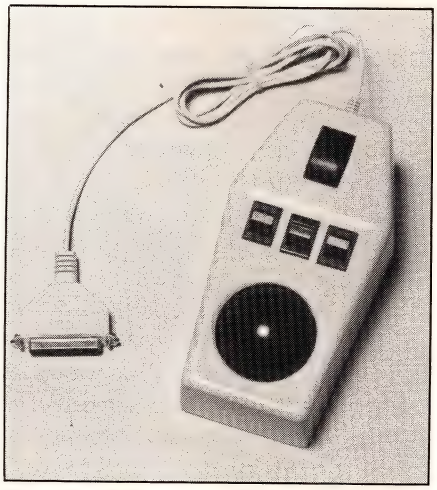
Low-cost trackball offers 3-D I/O control for CAE

When you're working with 3-dimensional images on your CRT, you can use the FastTrap pointing device to inject X-, Y-, and Z-axis data directly into a variety of application programs. The FastTrap is a 3-axis I/O device that provides you with the stability and resolution of a trackball but costs only $149.

Unlike mice, which require a minimum of 60 in^2 of desk space to operate, FastTrap occupies only 18 in^2. In addition, FastTrap doesn't require a special work-surface texture and isn't as sensitive to dust as a mouse is. The pointing device also eliminates the jitter that mice often cause in high-resolution applications.

Each unit houses a 200-pulse/in. trackball for X- and Y-axis input and a 200-pulse/in. fingerwheel for Z-axis input. Most mice offer only half this resolution, and none provide Z-axis input. The FastTrap device emits pulses to indicate motion in each axis; your application software interprets the trackball movements to change the position of the screen cursor.

FastTrap plugs into the serial port of any IBM PC or compatible computer via its RS-232C interface. The device comes with an MS-DOS/PC-DOS software driver for ease of installation. To provide compatibility with existing software, FastTrap includes hardware emulation of mouse controllers. Three buttons enable you to make menu selections, and you can adjust the tracking drag to suit your application.



Providing 3-dimensional cursor control *at a resolution of 200 pulses/in., the FastTrap pointing device plugs into the serial port of any IBM PC or compatible computer via its RS-232C interface.*

FastTrap's tracking surface provides a high degree of stability in high-resolution graphics applications. Certain CAE/CAD software packages, such as AutoCAD, currently offer 3-dimensional capability, but with an ordinary mouse or trackball you'd have to enter all Z-axis information from the keyboard. By integrating a FastTrap device in your CAE/CAD system, however, you can enter the Z-axis information with the pointing device, thus enhancing the functionality of your 3-dimensional software.

To aid software developers who want to use FastTrap's features in their programs, the manufacturer will furnish applications information, complete product data, and source code.—***J D Mosley***

MicroSpeed Inc, 5307 Randall Pl, Fremont, CA 94538. Phone (800) 232-7888 or (415) 490-1403.

Circle No 728

The winner! In price, performance… and speed!

Our PM 5786 pulse generator is way ahead in price, versatility, speed and ease of operation. It's priced at a level you won't find anywhere else. This instrument covers virtually every analog and digital requirement, with a high speed performance of 125 MHz/ 2 ns transition speed that's ideal for testing fast circuitry.

- **Unique warning LED's** make it unbeatably easy to set up, by giving an instant indication of any erroneous time settings.
- **The dual output** with choice of bipolar, positive or negative output pulses reduces the need for manual setting even further.
- **The preset burst option** (PM 5786 B) facilities testing of memories, shift registers and other digital circuitry.

Test the difference

- **Product Credibility** in technology, technique, quality and service is assured because the PM 5786 is backed by the corporate resources of one of the world's largest electronics companies.

Test the difference and you'll also agree that Philips wins on price and performance!

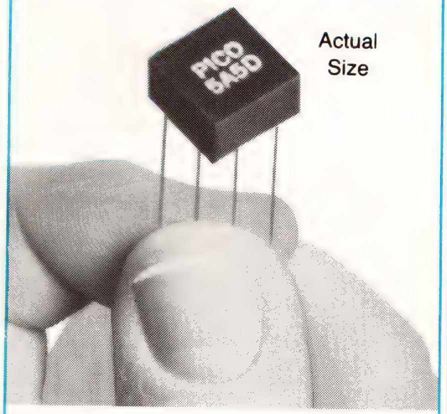
Write to: Philips I&E, T&M Department.
Building HKF/55.5600 MD Eindhoven.
The Netherlands: 040-78 28 08
Germany: (0561) 50 14 86
Great Britain: 0223-35 88 66
France: 01-4830 11 11
Belgium: 02-525 6692/525 6694
Switzerland: 01-488 22 11
Italy: 039-3635240/8/9

PHILIPS
Test & Measurement

PHILIPS

CIRCLE NO 56

PICO
DC-DC Converters
DELIVERY—STOCK TO ONE WEEK!



PICO's high reliability DC-DC Converters are produced in an ultra-miniature encapsulated package.
Over 80 different models operating over the temperature range of −25°C to +70°C without derating.

- Up to 250V DC Output
- Up to 1.25 watt output at 70°C ambient
- Ultra-miniature size (0.3″ Height)
- 5 input voltage ranges 5, 12, 24, 28 and 48V DC
- 28V Input/Output now standard
- Input/output isolation 100 megohm @ 500V DC
- Single and dual output
- No heat sink required

OPTIONS AVAILABLE:
Environmental screening per MIL-STD-883 and expanded operating temp. (−55°C to +85°C)

Over 300 miniature low profile standard models deliver up to 12 watts power.

PICO also manufactures over 2500 standard ultra-miniature transformers and inductors.

Delivery—stock to one week

SEE EEM, GOLD BOOK OR THOMAS REGISTER OR SEND DIRECT FOR FREE PICO CATALOG

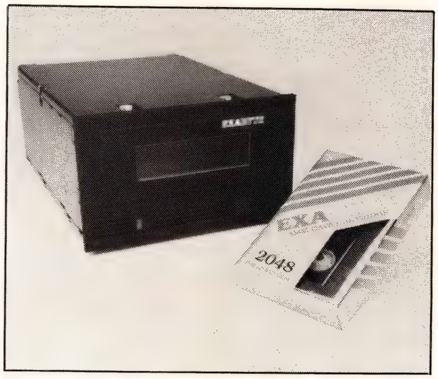
PICO Electronics, Inc.
453 N. MacQuesten Pkwy. Mt. Vernon, N.Y. 10552
Call Toll Free 800-431-1064
IN NEW YORK CALL 914-699-5514

Tape drive stores 2G bytes in a 5¼-in. form factor

Employing high-volume, consumer videotape technology, the EXB-8200 cartridge-tape subsystem stores 2.332G bytes on a 360-ft, 8-mm videotape cartridge. The subsystem includes the tape drive, controller electronics, a 256k-byte data buffer, and an embedded SCSI interface in an industry-standard, full-height, 5¼-in. form factor.

Although the actual tape speed is a leisurely 0.429 ips (allowing for very gentle tape handling), the subsystem's helical-scan record-and-playback drum rotates at 1800 rpm, creating an effective head-to-tape speed of 150 ips. The recording head places tracks diagonally on the tape, storing 8k bytes per track at a density of 819 tpi. The drive achieves an area recording density of 35M bits/in^2.

Reed-Solomon product-code error correction and extensive error-recovery procedures give this storage peripheral a nonrecoverable error rate of less than one error per 10^{13} bits read. The subsystem's separate read and write heads allow for read-after-write verification. If a 1k-bit block within an 8k-bit track produces a verification failure, that block is rerecorded on a subsequent track; the subsystem handles recording errors on the fly, without stopping or reversing tape motion.



Packing 2.332G bytes onto a standard 8-mm videotape cartridge, *the EXB-8200 cartridge-tape subsystem fits into a 5¼-in. form factor. The peripheral's embedded SCSI interface supports continuous data-transfer rates of 246k bytes/sec and burst rates of 1.5M bytes/sec.*

The subsystem sustains a continuous transfer rate of 246k bytes/sec over the SCSI interface, and the internal 256k-byte data buffer allows for a burst-transfer rate of 1.5M bytes/sec. The peripheral supports ANSI version 17B, conformance level 2, of the SCSI specification for sequential-access devices. It also provides full disconnect, arbitration, and reconnect functions. Because it includes the data buffer, the drive can simulate start/stop tape operation by fulfilling data requests directly from buffer storage instead of tape, as long as the desired information is in the buffer. The data-buffer-access time is 400 µsec.

The environmental specifications for the drive include an operational temperature range of 5 to 45°C at a relative humidity of 20 to 80%. The subsystem's voltage requirements are 5 and 12V; it dissipates 15W. You can purchase off-the-shelf 8-mm video cartridges for use with this product at less than $20 per cartridge. The manufacturer plans to offer certified media as well. One evaluation unit costs $3500; the price drops to less than $1000 per unit for large OEM quantities.

— Steven H Leibson

Exabyte Corp, 4876 Sterling Dr, Boulder, CO 80301. Phone (303) 442-4333. TLX 361740.

Circle No 727

CIRCLE NO 23

QUALITY LEADERSHIP IN CHIP AND DIPPED TANTALUM

- ■ Molded Tantalum chips designed for high speed pick and place equipment: Meet and exceed EIA standards (QC300801/US0001): Suitable for even the most demanding applications
- ■ A full range of dipped Tantalum capacitors offers alternatives for every requirement
- ■ All manufacturing locations IECQ approved
- ■ National distribution network ensures ready availability of product

For more information call our toll free number: USA – 800-624-6491; Canada – 800-624-6494, or complete the reply slip below

Tantalum Capacitors
Solid Tantalum Range

STC

STANTEL 636 Remington Road, Schaumburg, Illinois 60173

Name: ______________ Company: ______________

Address: ______________

Tel: ______________ Position: ______________

EDN031887

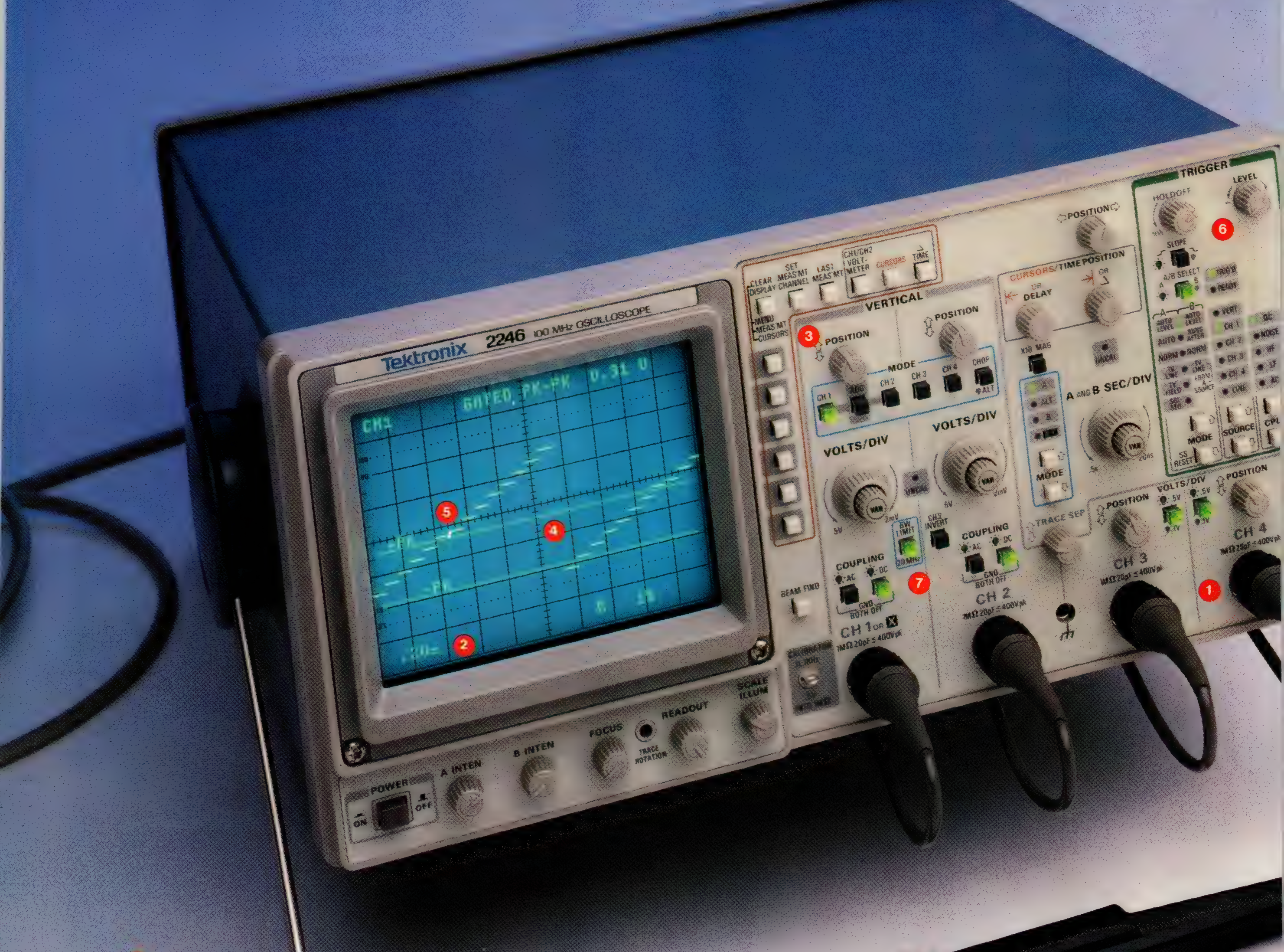
STANTEL

DEDICATED TO EXCELLENCE IN TANTALUM

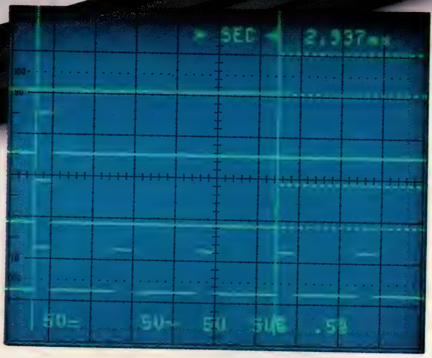
Tel: 312-490-7150 (East)
Tel: 805-495-8667 (West)
TWX: 910-291-1280. Fax: 312-490-9707

CIRCLE NO 139

New GPS Series with SmartCursors



❶ Four channels with 100 MHz bandwidth. ❷ CRT readout of scale factors and measurement results. ❸ Menu functions controlled by the top row of push buttons. ❹ SmartCursors™ track ± peak or peak-to-peak voltage measurements. ❺ Gated voltage mode makes it possible to itensify a portion of a waveform and make voltage measurements on that segment only. ❻ Versatile triggering lets you trigger the main or delayed sweep on any of the four channels. ❼ Backlit control buttons verify that a function is active.



The 2246 provides direct time readout information when seconds is selected in cursor mode. You also have 1/seconds in Hz and phase capability.

Copyright © 1986, Tektronix, Inc. All rights reserved. TTA-682.

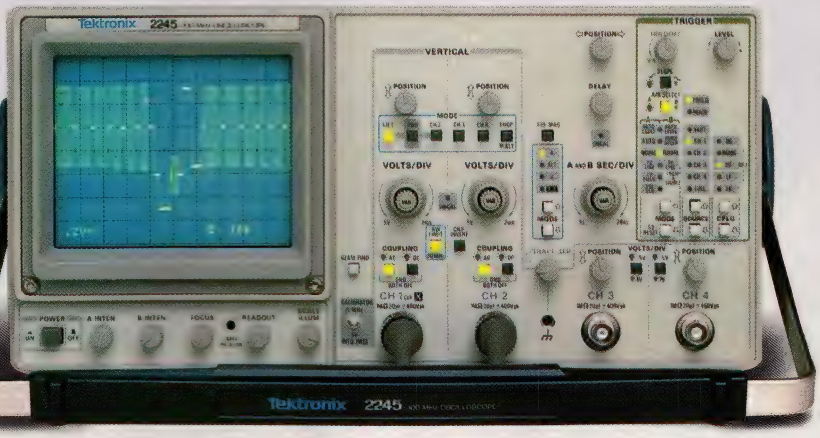
ek sets the pace nd push-button ease.

Work faster, smarter, with two new general purpose scopes from Tek. The four-channel, 100 MHz 2246 and 2245 set the new, fast pace for measurements made daily at the bench or in the field. They're easy to use and afford, by design. And backed by Tek's three-year warranty that includes the CRT.

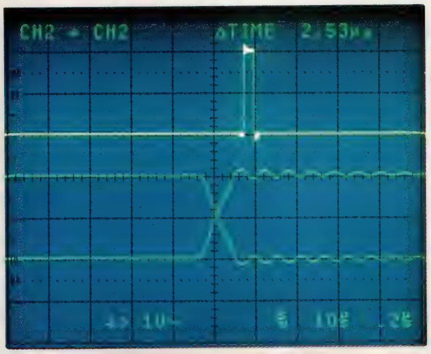
On top: the 2246 with exclusive integrated push-button measurements. Your measurements are accessed through easy, pop-up menus and implemented at the touch of a button. Measure ± peak volts, peak-to-peak, dc volts and gated volts with new hands-off convenience and on-screen readout of values.

SmartCursors™ track voltmeter measurements in the 2246 and visually indicate where ground and trigger levels are located. Or use cursors in the manual mode for immediate, effortless measurement of waveform parameters like voltage, time, frequency, and phase.

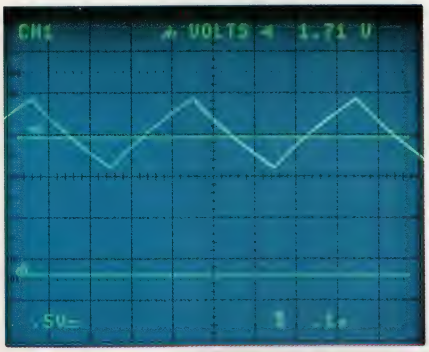
Both scopes build on performance you haven't seen at the bandwidth or prices. Lab grade features include sweep speeds to 2 ns/div. Vertical sensitivity of 2 mV/div at full bandwidth for low-level signal capture. Plus trigger sensitivity to 0.25 div at 50 MHz, to 0.5 div at 150 MHz.



Features	**2246**	**2245**
Bandwidth	100 MHz	100 MHz
No. of Channels	4	4
Scale Factor Readout	Yes	Yes
SmartCursors™	Yes	No
Volts Cursors	Yes	No
Time Cursors	Yes	No
Voltmeter	Yes	No
Vertical Sensitivity	2 mV/div	2 mV/div
Max. Sweep Speed	2 ns/div	2 ns/div
Accuracy: Vert/Hor	2%/2%	2%/2%
Trigger Modes	Auto Level, Auto, Norm, TV Field, TV Line, Single Sweep	
Trigger Level Readout	Yes	No
Weight	16.5 lb/7.5 kg	16.5 lb/7.5 kg
Warranty	3-year on parts and labor including the CRT	
Price	$2400	$1875



Conventional ΔTime measurement is also available from the menu in the 2246 for increased timing accuracy. Shown above: a ΔTime measurement of pulse width.



The 2246 also makes it possible to measure either ΔVolts or absolute volts from ground.

Best of all, high performance comes with unmatched convenience. You can see it and feel it—in the responsive controls and simple front-panel design, in extensive on-screen scale factor readouts, and in simplified trigger operation that includes Tek's Auto Level mode for automatic triggering on any signal. Start to finish, the GPS Series saves steps and simplifies tasks.

Get out in front! Call toll-free today to order, to get more details or a videotape demonstration.
1-800-433-2323
In Oregon, call collect
1-627-9000

Tektronix®
COMMITTED TO EXCELLENCE

CIRCLE NO 145

The GE/RCA ASIC cell library:

where best-sellers begin.

With one of the largest standard cell and gate array libraries, and a first-time success rate of virtually 100%, GE/RCA has all the tools you need to design leading-edge products.

The GE/RCA library of hundreds of verified cells and functions is one of the broadest in the industry.

We have cells with effective gate length as small as 1.5μ (.9μ coming soon). And double-level metal for higher-density chips that handle higher clock speeds.

You can choose from a wide range of Supercells, including core micros, RAMs, analog functions and bit-slice processors. Right now, we're working on new editions, including Advanced CMOS Logic, EPROMs and high-voltage cells. Additionally, we can generate custom cells to meet your requirements.

So you can easily reduce an entire system onto a single ASIC chip, and get the ASIC benefits of smaller power supplies, lower system cost and higher reliability.

Plus a full library of gate arrays.

If your design calls for gate arrays, you can select from a broad line with up to 13,000 gates. With alternate sourcing on the LSI/Toshiba series.

GE/RCA gate arrays have effective gate lengths as small as 1.2μ. And they're compatible with the industry standard.

Writing made easy.

We've made it easy for you to write your best-selling design.

Our designer-friendly software gets you up to speed in as little as the three days it takes to complete our training course.

And our software supports the major workstations in the industry, including Daisy,™ Mentor Graphics,™ Valid,™ P-CAD® and FutureNet.®

Through the use of Twins, our transparent workstation interface system, you can complete or revise your design at practically any workstation.

We're also in the forefront of silicon compiler technology. So we can offer you the ability to create designs that are heavily BUS-structured, with your ROMs, RAMs, PLAs and ALUs compiled right into the design.

The best editors in the business.

We know how important accurate performance modeling is to you. That's why we've developed the industry's most advanced simulation and parasitic extraction programs, which make it easy to create designs that work. In fact, our first-time success rate is virtually 100%.

And you can count on our ASICs specialists for technical support from design through production. One other thing you can count on with GE/RCA: there are no hidden charges in addition to your NRE.

On the best-seller list for years.

GE/RCA has been the CMOS company since the day we invented the technology. We've produced one best-selling CMOS circuit after another. And built the industry's broadest line of High-Rel CMOS parts, including super radiation-hardened Silicon-on-Sapphire.

With all this behind you, think how easy it could be to design a best-seller.

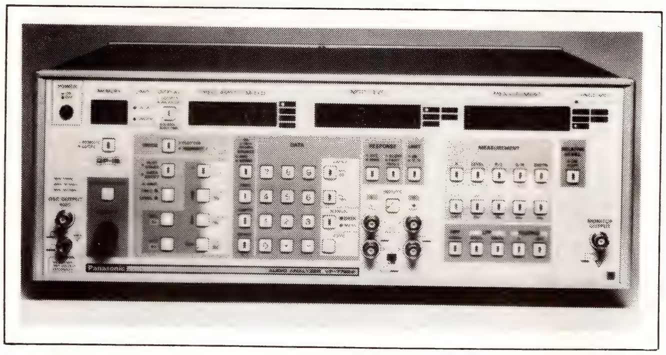
For more information, call toll-free 800-443-7364, ext. 14. Or contact your local GE/RCA sales office or distributor.

Daisy™ is a trademark of Daisy Systems Corp.
Mentor Graphics™ is a trademark of Mentor Graphics Corp.
Valid™ is a trademark of Valid Logic Systems Inc.
FutureNet® is a registered trademark of FutureNet, a Data I/O Company.
P-CAD® is a registered trademark of Personal CAD Systems, Inc.

GE RCA

READERS' CHOICE

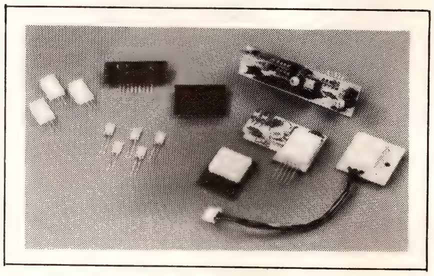
Of all the new products covered in EDN's **January 8, 1987,** issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **January 8, 1987,** issue.



▲ AUDIO ANALYZER

The VP-7722P dual-channel audio analyzer has a 10-Hz to 110-kHz frequency range. It measures total harmonic distortion digitally (pg 283).

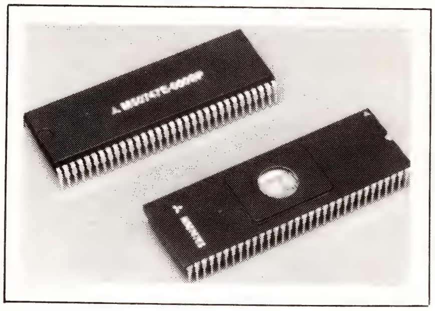
Panasonic Industrial Co.
Circle No 605



▲ HUMIDITY SENSOR

You can use the RH-8 bulk-resistance-polymer relative-humidity sensor and the SCMC-I and SCMC-V signal-conditioning microcircuits for constructing humidity transmitters (pg 247).

General Eastern Instruments Corp.
Circle No 601



◀ MICROCONTROLLER

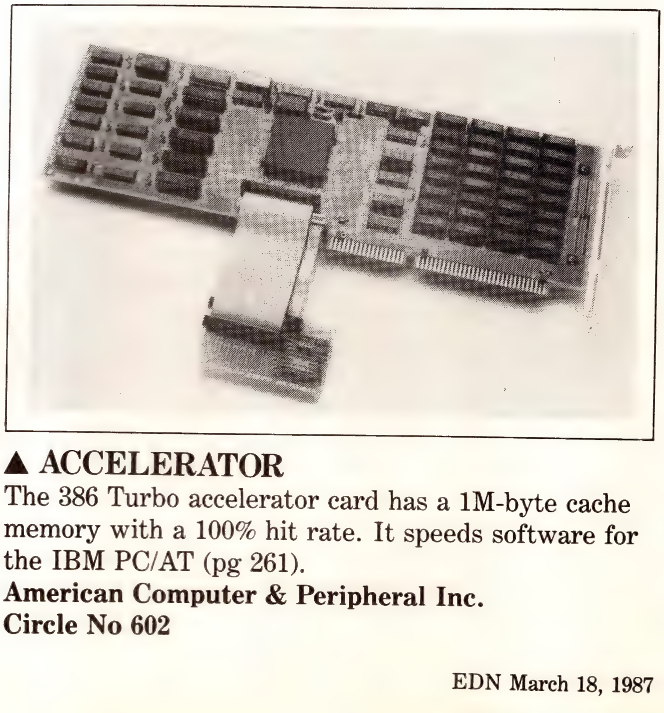
The Model M50747ES microcontroller contains 8k bytes of EPROM and 256 bytes of RAM and comes in a one-time-programmable version (pg 277).

Mitsubishi Electronics America Inc.
Circle No 604

C INTERPRETER

Instant-C 2.0 is an enhanced version of a C-language interpreter/compiler that runs on the IBM PC and compatibles. It has a full-screen, memory-resident editor for correcting source code (pg 272).

Rational Systems Inc.
Circle No 603

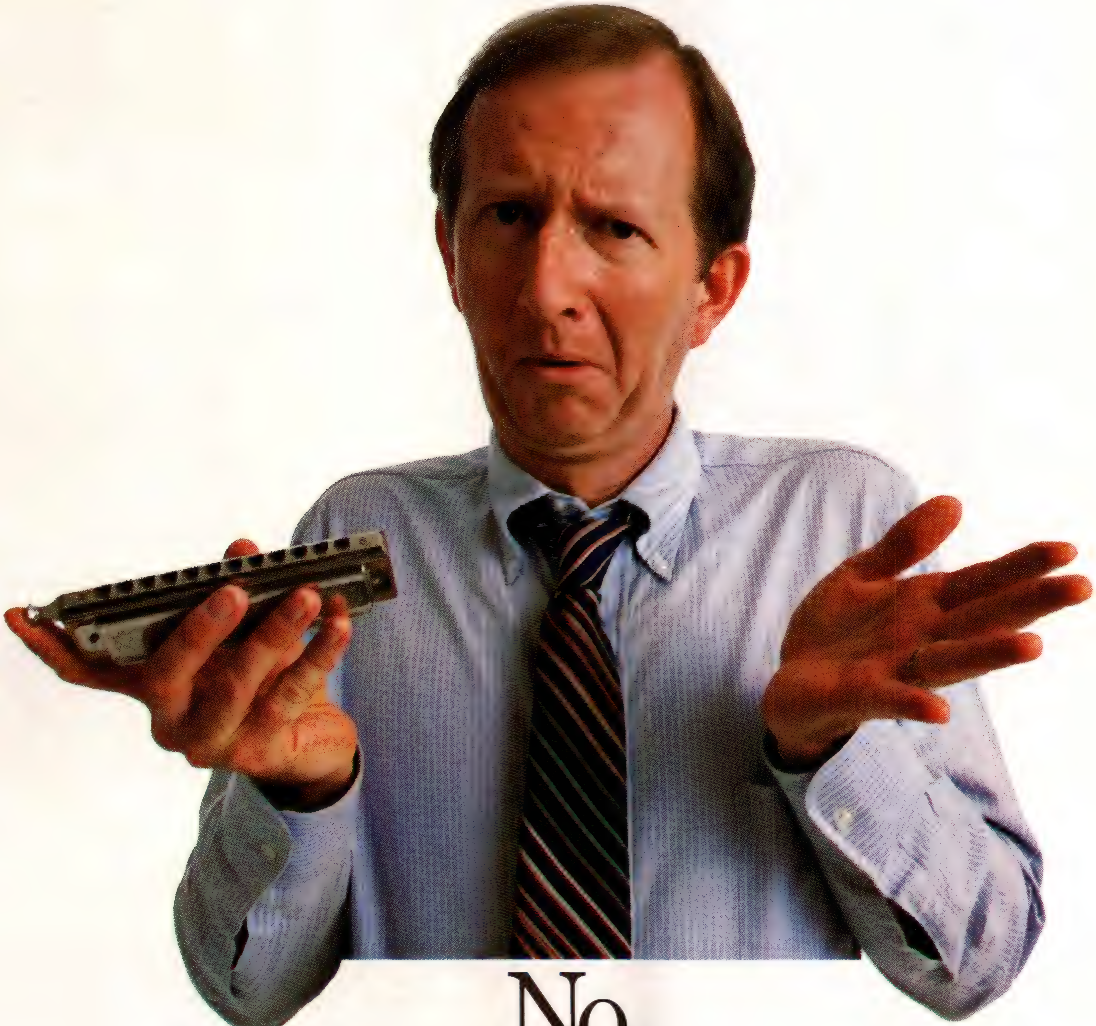


▲ ACCELERATOR

The 386 Turbo accelerator card has a 1M-byte cache memory with a 100% hit rate. It speeds software for the IBM PC/AT (pg 261).

American Computer & Peripheral Inc.
Circle No 602

You've made power supplies smaller, lighter and quieter with a harmonica?



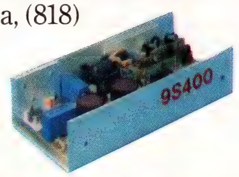
No, Harmonic Resonance!

Harmonic resonant, as a technology for our new line of power supplies, is practically as significant as going from linear to switching.

So, why did we develop it? It lets us make open frame switchers almost half the size of industry standards. Therefore, lighter. And quieter from a conductive noise standpoint. All for the same price you're paying now.

Of course, like all our power supplies introduced since 1983, this new 9S Harmonic Resonant line meets VDE, UL and CSA for safety. And VDE, FCC and IEC for conducted noise.

For more information on our new 9S Harmonic Resonant line (or where to get a nice harmonica), contact us today. Sierra Power Systems (formerly Sierracin), 20500 Plummer Street, Chatsworth, California 91311. Call toll-free (800) 423-5569. In California, (818) 998-9873.



Sierra Power Systems
Division of Valor Electronics, Inc.

CIRCLE NO 134

Freon® Solvent Cleaners

Select from high-purity Freon® based solvent cleaners anti-static sprays; flux removers; conformal coatings; release agents and more.

Wet Pads™

Use convenient Wet Pad™ high-purity pre-moistened solvent wipes. Freon® based cleaning solvents, CRT cleaners, and contact cleaners/lubricants are a few of the chemicals offered in Wet Pads™.

Freon® Flux Removers

Formulated for removal of all types of organic flux from PCB's and other electronic assemblies. Add our unique Cobra® Solvent Spray Brush to convert the aerosols into efficient spot-cleaning systems.

Aero-Duster®

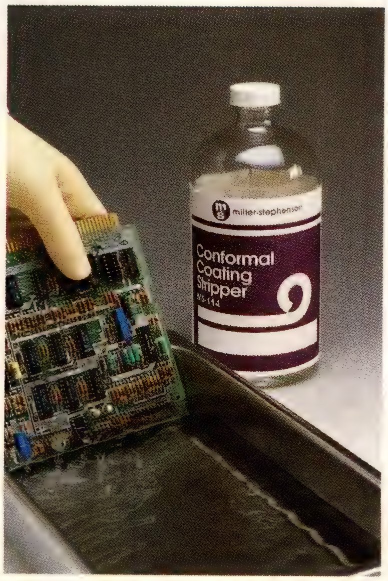
A dry, non-toxic, non-flammable gas for removing microscopic dust and oxide particles from tape heads, PCB's, optics and electronic assemblies.

Conformal Coatings

Since coating requirements are not the same for all applications, we offer you a choice of silicone, urethane, acrylic or varnish conformal coatings. All of our coatings provide excellent electrical insulation and moisture resistance. Available in convenient aerosol form.

Conformal Coating Strippers

Specially formulated for the removal of M-S coatings. Safely dissolves acrylic, urethane, silicone and varnish coatings without damage to most electronic components. We also offer strippers for epoxy systems.



Miller-Stephenson Chemical Co., Inc.

Los Angeles 12261 Foothill Blvd., Sylmar, CA 91342 (818) 896-4714
Chicago 6348 Oakton St., Morton Grove, IL 60053 (312) 966-2022

Danbury George Washington Hwy., Danbury, Conn., 06810 (203) 743-4447
Toronto 514 Carlingview Dr., Rexdale, Ontario M9W 5R3 (416) 675-3204

Freon® Solvents

Choose quart, gallon or 5-gallon sizes from our complete range of high-purity Freon® solvents for ultrasonic or bulk degreasing procedures. Residues are as low as 2 ppm.

Contact/ Connector Cleaners

Safely remove dirt and oxide build-up on tape heads, gold fingers and connectors. Choose Magnetic Tape Head Cleaner or Contact Re-Nu® in convenient aerosol or Wet Pad™. Also available with protective lubricants.

Freezing/Fault Isolation Products

Use our high-purity Quik-Freeze® for fault isolation, low temperature testing and component protection during soldering/desoldering. Also available in anti-static form for use on sensitive micro-circuits.

Fluorocarbon Release Agents

Select a fluorocarbon release agent for room temperature processing or heated molding application. These Teflon® type release agents contain no silicone oils and do not noticeably transfer to molded parts. Available in convenient aerosol or bulk packaging.

® Freon is DuPont's registered trademark for its fluorocarbon compounds. ® Teflon is a registered trademark of Du Pont. ® Registered trademark of Miller-Stephenson Chemical Co., Inc.

TRY IT.

We're certain that once you try our high-purity chemicals, you'll want to keep using them. For complete product literature and free samples, please fill out the coupon or call 203-743-4447. For technical service call 800-992-2424. 8—4 Eastern Time.

☐ Freon® Solvent Cleaners
☐ Wet Pads™
☐ Freon® Solvents
☐ Contact/Connector Cleaners
☐ Freon® Flux Removers
☐ Aero-Duster®
☐ Freezing/Fault Isolation Products
☐ Fluorocarbon Release Agents
☐ Conformal Coatings
☐ Conformal Coating Strippers

MAIL TO: Miller-Stephenson Chemical Co., Inc.
George Washington Highway
Danbury, Connecticut 06810

EDN3F

NAME ____________________
TITLE/DEPT. ____________________
COMPANY ____________________
ADDRESS ____________________
____

Los Angeles 12261 Foothill Boulevard, Sylmar, CA 91342 (818) 896-4714
Chicago 6348 Oakton Street, Morton Grove, IL 60053 (312) 966-2022
Danbury George Washington Highway, Danbury, Conn. 06810 (203) 743-4447
Toronto 514 Carlingview Drive, Rexdale, Ontario M9W 5R3 (416) 675-3204

Wet Pad™ Aerosol Bulk

miller-stephenson

CIRCLE NO 135

26% MORE FAST FUNCTIONS.

Signetics now has 26% more parts than the closest runner-up. That means for every four parts Fairchild makes, we make five.

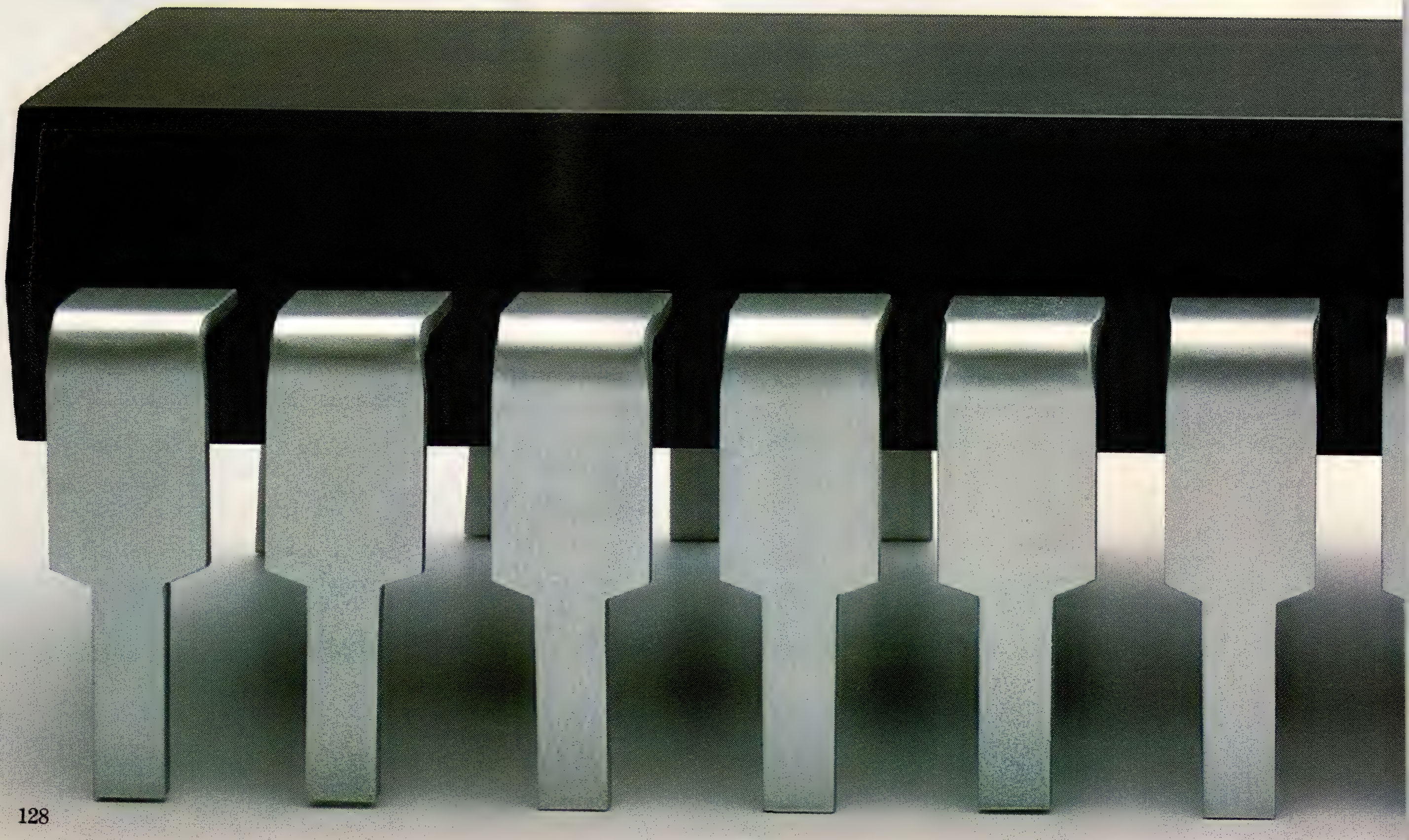
More state-of-the-art functions, too. Combined function products like octal buffers, transceivers with parity and latched or registered octal transceivers. We also make 9- and 10-bit transceivers, LSI DRAM controllers and the fastest 8-bit counters available.

We've got more design options, a unique bus-oriented input structure, and faster speeds. Surface mount packaging options with SO. All in volume, all ready to ship now.

As a matter of fact, Signetics has *doubled* its FAST™ production capacity since January '86.

FAST circuits from Signetics. Now we're leading the leader.

For more information on FAST ICs from Signetics call 800-227-1817, ext. 968D or send in the coupon.



One standard. 0 defects.

Signetics

a subsidiary of U.S. Philips Corporation

Please send more information on Signetics FAST ICs. EDN031887

Application______________________________

Name______________________________

Position______________________________

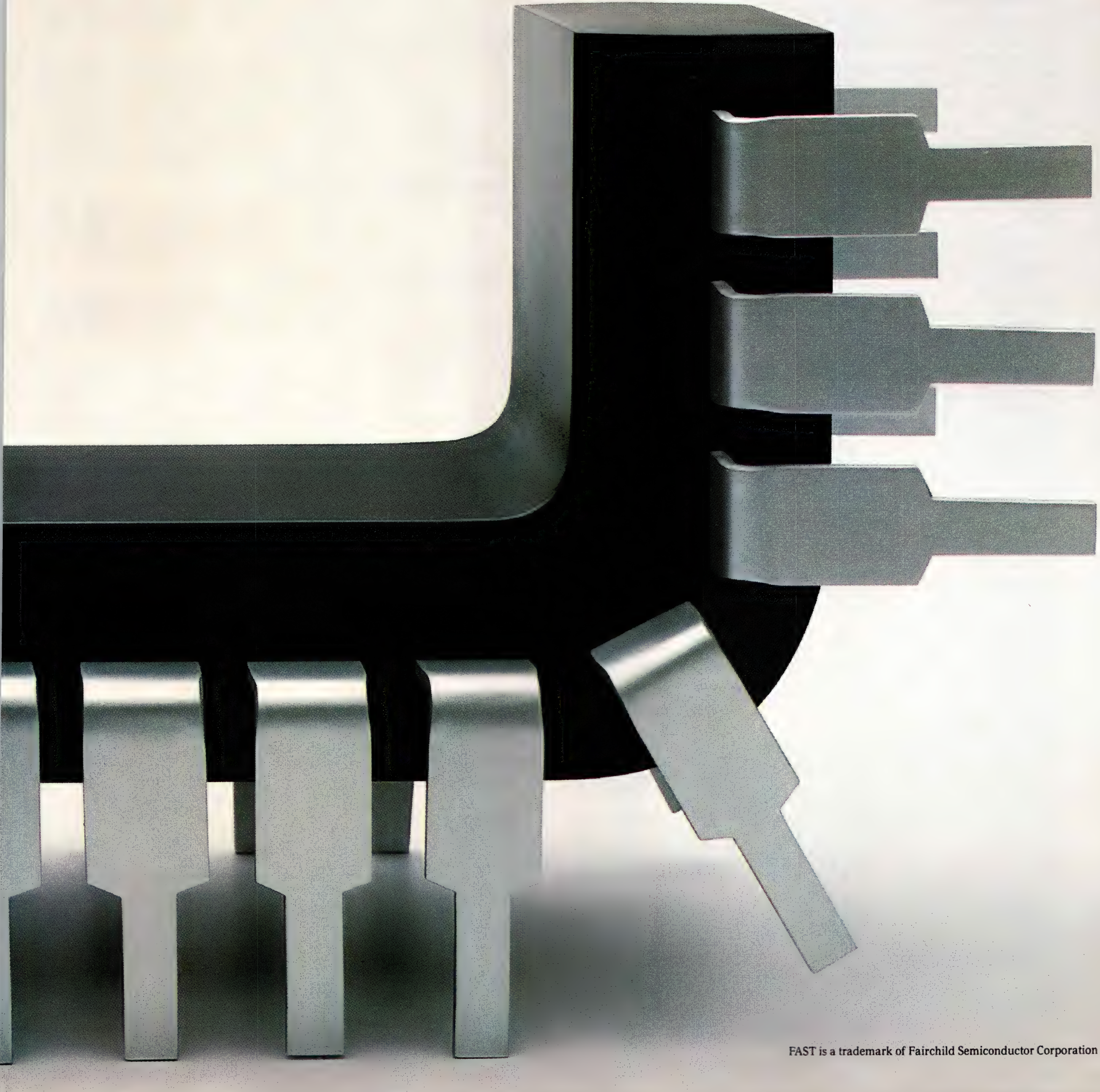
Company______________________________

Address______________________________

City______________State__________Zip__________

Phone______________________________

Send coupon to: Signetics Corporation, 811 E. Arques Ave., P.O. Box 3409, Sunnyvale,
CA 94088-3409. Attn: Publication Services, M/S 27. 968



FAST is a trademark of Fairchild Semiconductor Corporation

LEADTIME INDEX

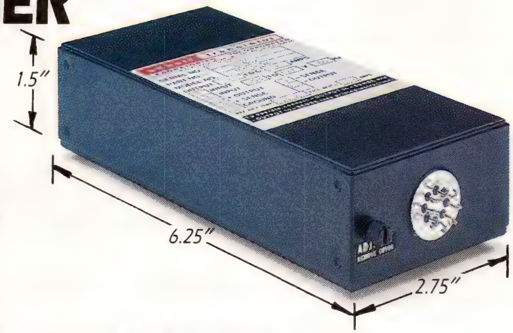
Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
TRANSFORMERS								
Toroidal	0	9	45	46	0	0	11.0	8.8
Pot-Core	0	13	50	37	0	0	10.2	10.5
Laminate (power)	7	13	47	33	0	0	9.3	8.0
CONNECTORS								
Military panel	0	25	25	25	12	13	13.7	8.8
Flat/Cable	21	47	16	16	0	0	5.1	5.9
Multipin circular	0	27	33	13	13	14	13.1	9.6
PC	0	64	18	18	0	0	6.2	5.7
RF/Coaxial	21	29	36	7	7	0	6.6	5.4
Socket	20	40	27	13	0	0	5.4	4.4
Terminal blocks	12	41	35	12	0	0	5.9	5.6
Edge card	13	33	40	14	0	0	6.3	7.0
Subminiature	20	30	40	10	0	0	5.7	6.4
Rack & panel	0	29	57	14	0	0	7.6	6.2
Power	15	31	39	8	0	7	7.6	7.4
PRINTED CIRCUIT BOARDS								
Single-sided	0	55	40	5	0	0	5.6	4.8
Double-sided	0	38	58	4	0	0	6.4	6.5
Multilayer	0	23	62	15	0	0	8.0	8.9
Prototype	0	79	11	10	0	0	4.8	4.4
RESISTORS								
Carbon film	50	29	21	0	0	0	2.5	4.2
Carbon composition	43	29	10	19	0	0	4.9	3.9
Metal film	44	16	36	4	0	0	4.0	4.5
Metal oxide	30	39	31	0	0	0	3.6	4.3
Wirewound	16	28	56	0	0	0	5.3	2.4
Potentiometers	17	33	38	12	0	0	5.9	5.9
Networks	7	47	33	13	0	0	6.1	6.1
FUSES	29	29	35	7	0	0	4.8	2.4
SWITCHES								
Pushbutton	6	19	63	12	0	0	7.5	4.7
Rotary	5	18	65	12	0	0	7.5	5.7
Rocker	20	13	47	20	0	0	7.2	4.6
Thumbwheel	0	22	45	22	11	0	10.5	5.4
Snap action	20	20	30	20	10	0	8.7	3.5
Momentary	10	20	50	10	10	0	8.7	4.4
Dual in-line	17	33	17	17	16	0	9.2	4.2
WIRE AND CABLE								
Coaxial	43	28	29	0	0	0	3.1	1.8
Flat ribbon	47	20	33	0	0	0	3.3	1.7
Multiconductor	42	17	42	0	0	0	3.8	2.9
Hookup	61	30	9	0	0	0	1.6	1.5
Wire wrap	58	25	17	0	0	0	2.1	1.0
Power cords	36	23	36	5	0	0	4.3	4.3
Other	33	33	17	17	0	0	4.9	5.8
POWER SUPPLIES								
Switching	0	18	46	36	0	0	9.8	6.5
Linear	20	20	50	10	0	0	6.2	4.8
CIRCUIT BREAKERS	20	20	33	27	0	0	7.4	5.7
HEAT SINKS	27	20	47	6	0	0	5.4	3.9

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
RELAYS								
General purpose	28	22	39	11	0	0	5.5	5.2
PC board	0	25	58	17	0	0	8.0	8.1
Dry reed	25	25	37	13	0	0	5.7	6.9
Mercury	0	22	67	11	0	0	7.7	7.6
Solid state	21	36	29	14	0	0	5.6	8.9
DISCRETE SEMICONDUCTORS								
Diode	38	23	31	8	0	0	4.3	4.8
Zener	25	25	30	20	0	0	6.3	5.7
Thyristor	23	39	23	15	0	0	5.4	6.5
Small signal transistor	19	31	31	13	6	0	7.0	5.3
FET, MOS	24	23	18	35	0	0	7.6	7.6
Power, bipolar	25	8	33	34	0	0	8.1	4.8
INTEGRATED CIRCUITS, DIGITAL								
CMOS	10	26	32	32	0	0	8.2	6.4
TTL	31	19	38	12	0	0	5.5	6.5
LS	8	42	42	8	0	0	5.9	5.7
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	0	14	57	29	0	0	9.4	6.3
OP amplifier	10	20	40	30	0	0	8.5	6.5
Voltage regulator	11	33	39	17	0	0	6.7	6.6
MEMORY CIRCUITS								
RAM 16	37	18	27	18	0	0	5.5	4.0
RAM 64	20	40	30	10	0	0	5.2	4.2
RAM 256	20	20	40	20	0	0	6.9	5.0
ROM/PROM	22	22	45	11	0	0	5.9	5.3
EPROM	14	29	36	21	0	0	7.0	6.9
EEPROM	22	11	45	22	0	0	7.3	8.2
DISPLAYS								
Panel meters	11	45	33	11	0	0	5.7	6.4
Fluorescent	20	20	20	40	0	0	8.4	10.1
Incandescent	0	50	25	25	0	0	7.4	4.3
LED	17	33	33	17	0	0	6.3	5.6
Liquid crystal	0	31	46	23	0	0	8.2	7.2
MICROPROCESSOR ICs								
8-bit	27	9	37	27	0	0	7.4	4.2
16-bit	20	10	50	20	0	0	7.4	2.9
FUNCTION PACKAGES								
Amplifier	25	0	50	12	13	0	9.1	4.9
Converter, analog to digital	0	30	50	20	0	0	8.0	8.6
Converter, digital to analog	0	22	56	22	0	0	8.6	8.5
LINE FILTERS	11	33	34	22	0	0	7.1	6.4
CAPACITORS								
Ceramic	13	39	35	9	4	0	6.4	5.2
Ceramic monolithic	19	19	37	19	6	0	8.1	5.5
Ceramic disc	14	33	29	19	5	0	7.5	5.5
Film	10	30	35	20	5	0	8.1	5.9
Electrolytic	21	25	33	21	0	0	6.6	6.6
Tantalum	13	22	52	13	0	0	6.8	6.6
INDUCTORS	0	18	64	18	0	0	8.5	5.5

Source: *Electronics Purchasing* magazine's survey of buyers

ABBOTT'S NEW M25; A HIGHER PERFORMANCE, 25-WATT SWITCHING POWER SUPPLY



Abbott's new M25 exceeds the performance of one of the best selling mil-spec power supplies; our own VN25. Our VN25 has been widely used in critical naval and airborne applications for over 10 years. Now the M25 offers higher performance in this proven design.

Higher Density. *The M25 has a 1¼ inch lower profile than our VN25 while maintaining the same footprint. This adds up to a* ***45% reduction*** *in volume.*

Better Specs. *By doubling the switching frequency, our M25 is 10% more efficient, while at the same time providing a* ***23% wider*** *operating temperature range.*

Greater Reliability. *By using innovative design techniques, the M25 achieves a* ***4-fold increase*** *in MTBF.*

EMI Compliance. *All M25 standard units meet MIL-STD-461B for emissions and susceptibility.*

The M25 is encapsulated and hermetically sealed, and meets the stringent environmental requirements of MIL-STD-810C and MIL-S-901C.

Abbott's new M25: higher performance in a proven design.

Call or send for specs and our full line catalog.

Abbott Transistor Laboratories, Inc. Power Supply Division, 2727 La Cienega Blvd., Los Angeles, CA 90034 (213) 936-8185. Eastern Office: (201) 461-4411, Southwest Office: (214) 437-0697, London Office: 0737-82-3273.

MODEL M25 SPECIFICATIONS

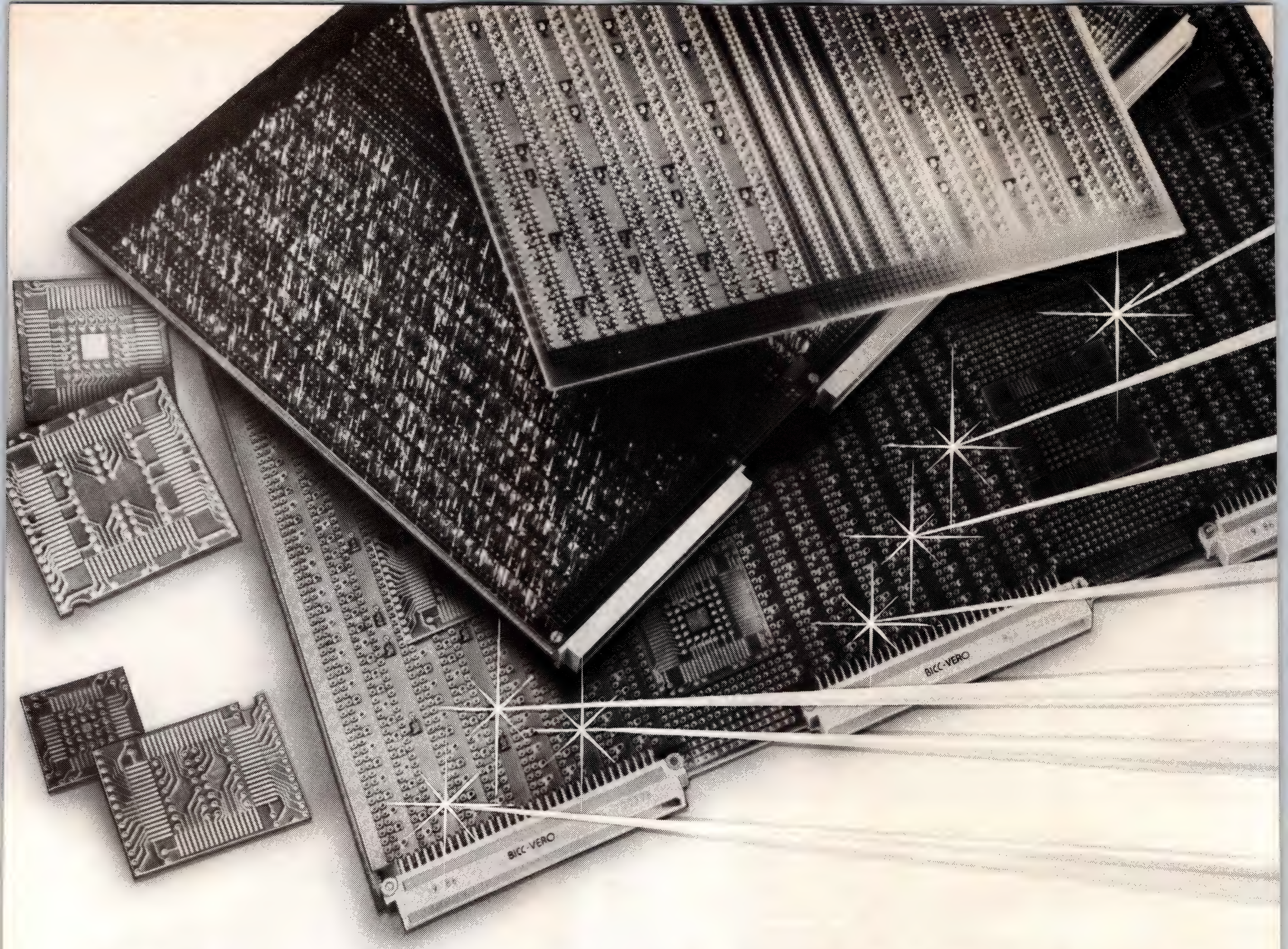
DIMENSIONS	**6.25"x 2.75"x 1.5"**
Input frequency	*47-440 Hz*
Input voltage	*103.5 to 126.5 V rms*
Outputs	*5, 12, 15, 24, 28 V*
Efficiency	*70% minimum*
Ripple/noise	*20 mV rms/100 mV p-p*
Line regulation	*10 mV*
Load regulation	*25 mV*
EMI	*MIL-STD-461B*
Environment	*MIL-STD-810C* *MIL-S-901C*
Input protection	*MIL-STD-1399 sec 103*
Operating temperature range	*−20°C to 71°C*
Storage temperature range	*−55°C to 85°C*
MTBF (ground benign)*	
Standard	*176,000 hours*
ER Option	*759,000 hours*
MTBF (naval sheltered)*	
Standard	*33,000 hours*
ER Option	*125,000 hours*

**MIL-STD-217D (50°C baseplate)*

abbott

MILITARY POWER SUPPLIES

CIRCLE NO 137

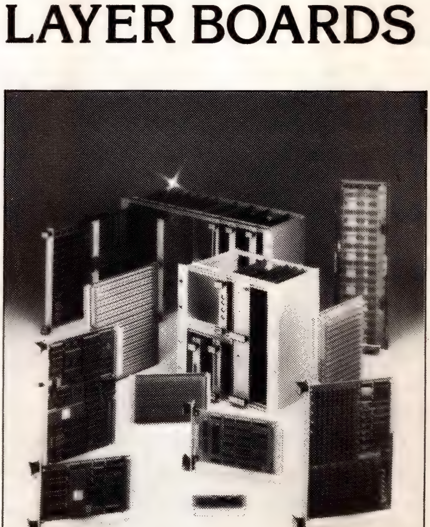


When Speed is Critical...

BICC-VERO MULTILAYER BOARDS ARE BEST!

High speed digital and analog circuits require close control of propagation times for error-free operation. BICC-VERO multi-layer wire wrap boards provide the ideal connection and transmission medium. Three independent voltage planes and a full ground plane, any of which that can be tied to any other, allow controlled impedance and distributed capacitance. In addition, surface mounted capacitors provide distributed decoupling and charge storage over the entire board.

Available in 6 Eurocard sizes of single, double, and triple height boards, the high density pin pattern accepts 0.3, 0.4, 0.5, and 0.6 DIP packages, pin grid array devices, or surface mounted devices using one of a series of BICC-VERO surface mount adapters. Adapters accept 28, 44, 68, and 84 pin packages, gullwing, or J lead. A pin grid array simulator adapter is also available for developing circuit functions that will eventually be integrated into a custom package.



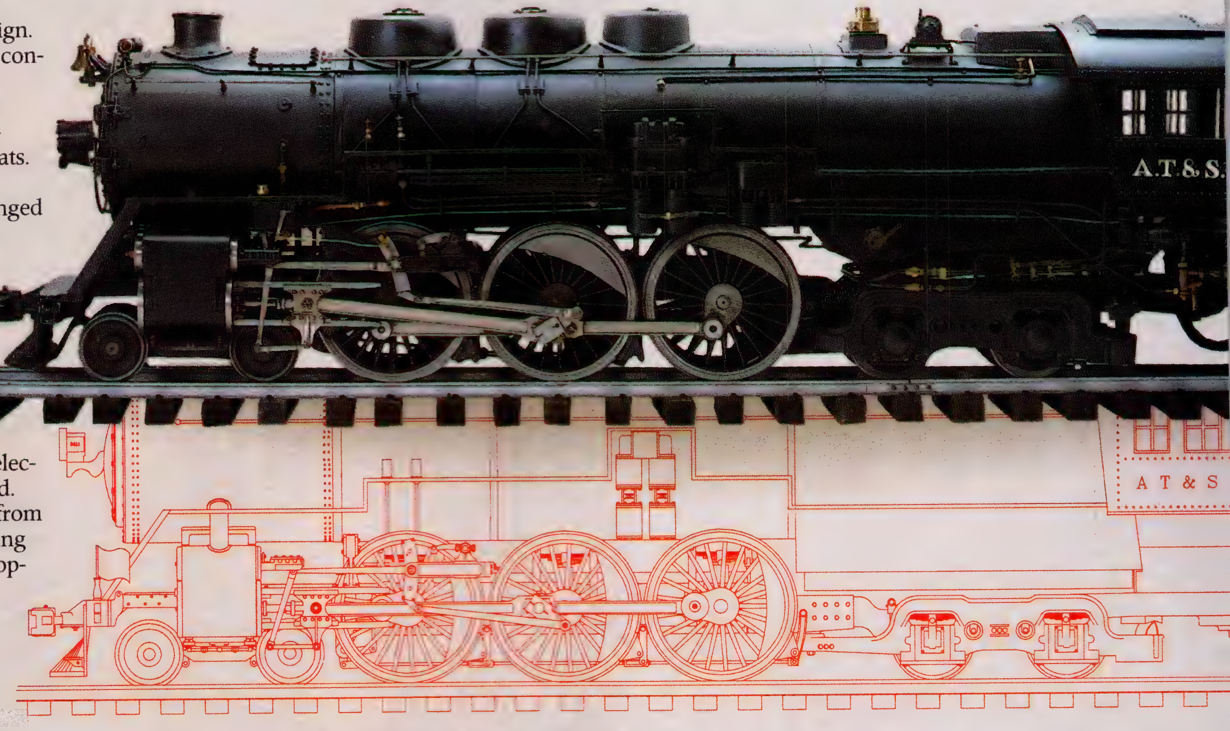
BICC-VERO supports their multi-layer boards with a full line of card frames, enclosures, and connectors. Ask for the details.

Your BICC-VERO representative has the full information. Give him a call.

VERO
BICC ELECTRONICS

BICC-VERO ELECTRONICS, INC.
1000 Sherman Avenue Hamden, CT 06514
(203) 288-8001 TWX: 510-227-8890

Put yourself on the right track with CAD.



Computer-aided design.

Until recently, it conjured up images of massive, room-sized computers and engineers in white lab coats.

But a few years ago, AutoCAD® changed all that. With a software package that turned the personal computer on your desk into an easy-to-use electronic drawing board.

For everything from PC boards to shopping centers. Tooling to topographical plans. Technical illustrations. Facilities layouts.

Even #4-6-4 Hudson model railroad trains.

Now AutoCAD is even better.

Introducing AutoCAD 2.5

Of course, the newest version of AutoCAD still has all the features that made the original the industry standard. Accuracy, Power, and Versatility.

But now, there are improvements all down the line.

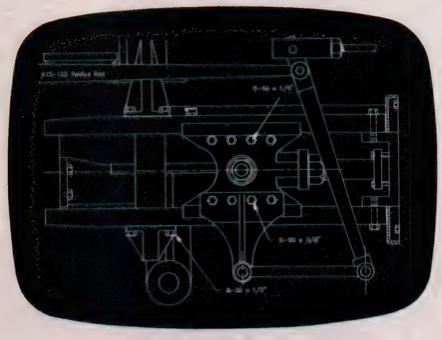
For example, AutoCAD performs most PAN and ZOOM operations five to ten times faster than the previous version. So design and redesign are faster than ever.

There is also a wealth of new commands for creating ellipses, doughnuts, and polygons. And new editing commands that let you STRETCH, TRIM, EXTEND, ROTATE, SCALE, and EXPLODE objects.

The result? A powerful electronic drawing tool that lets you concentrate on the drawing, and not on the electronics.

Feel Comfortable at the Controls

Never used a computer before? AutoCAD's easy-to-use menus guide you from action to action. You can even create your own menus. And use an on-line "HELP" command if you get stuck.



Save hours of drafting time. Draw frequently used diagrams just once and re-enter where needed.

What if you have second thoughts, or make a mistake? AutoCAD's new, sweeping UNDO capability lets you erase what you've done—so you have total freedom to draw and experiment.

There are also enhanced customization features. Support for over 30 different microcomputers (as well as several 32-bit UNIX-based systems). Even support for the new IGES standard, to let you easily and accurately translate drawings between AutoCAD and most other CAD systems.

All of which combine to make the new AutoCAD fit more neatly and comfortably than ever into the way you're used to working.

How to Get on Board

For a demonstration of AutoCAD 2.5, or any of our other products, call or write us for the name of the dealer nearest you.

Call us too if you want the location and telephone number of your nearest AutoCAD Authorized Training Center.

We'll make sure you get headed down the right track.

AUTOCAD®

AUTODESK, INC.
2320 MARINSHIP WAY
SAUSALITO, CA 94965
(800) 445-5415
TELEX 275946 ACAD UD

Drawings Courtesy of Little Engines, Inc.

DON'T MISS AUTOCAD® EXPO-'87, JUNE 23-26 AT THE WASHINGTON, D.C. CONVENTION CENTER.

CIRCLE NO 102

The only integrated CAE environment.

The Total Engineering Solution

CASE Technology offers the only fully integrated CAE system that operates on standard IBM PC/XT/ATs, MicroVAX workstations and VAX minicomputers. The system includes: schematic design, 12-state logic and fault simulation, worst-case timing verification, circuit simulation, and PCB physical layout.

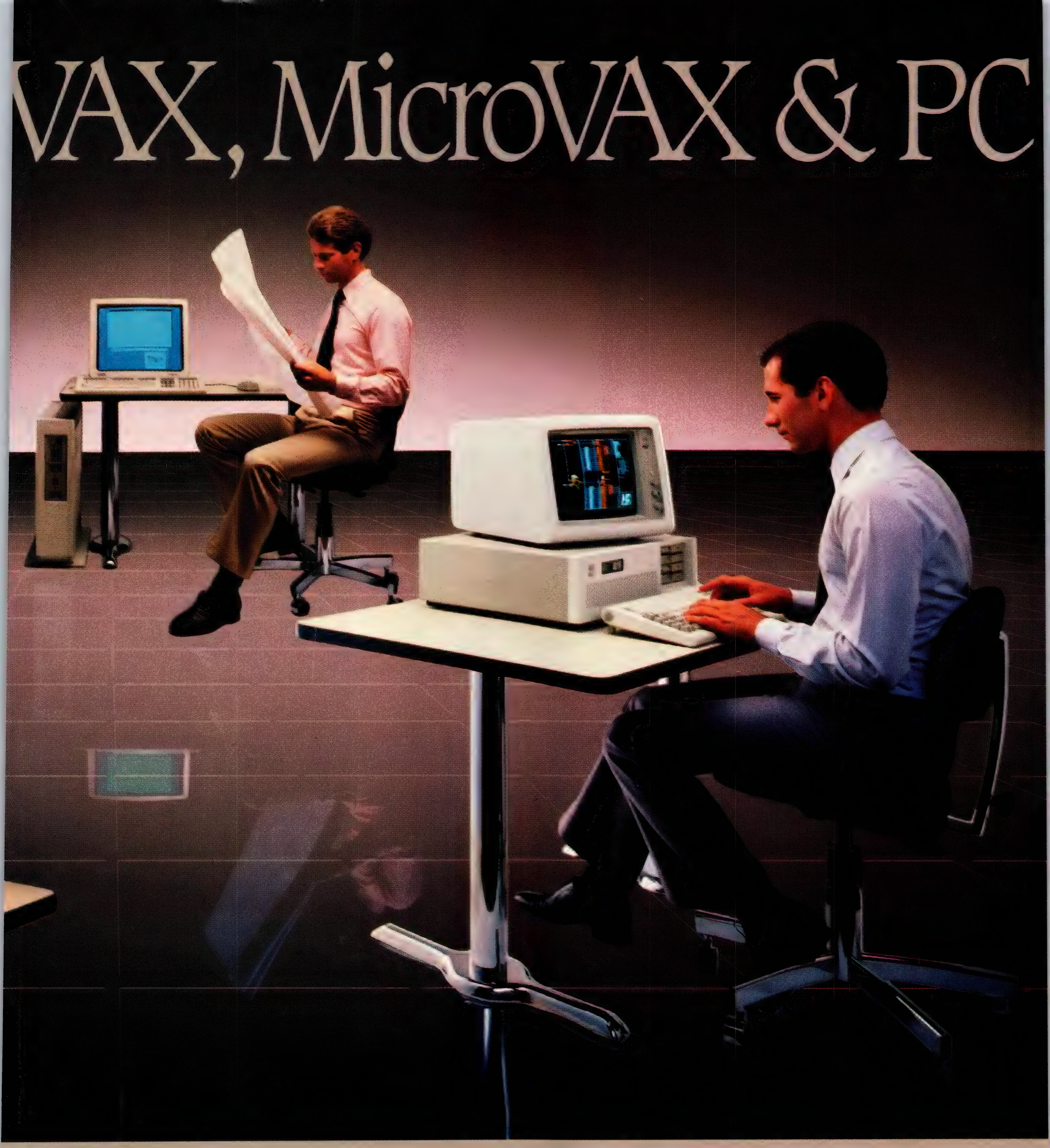
The CASE system possesses the most powerful schematic design tools available. Its power lies in its interactive speed, intelligent user interface and system configurability. The system also supports the complete SCALD hierarchical design concepts.

Intelligent Schematics—The Nucleus of Custom CAE

With CASE schematic design as the nucleus of your CAE environment, you can use each CAD/CAE system to do what it does best. You're not locked into one vendor. Integrate Tegas, Spice, Cadat, Silos, Scicards, Redac, Computervision, Applicon, Calay, Telesis, Mentor, IBM CBDS and Prime EDMS.

One Schematic is Worth a Thousand Netlists

The CASE system saves you hundreds of man-hours by allowing a bi-directional interface with other design



systems. This capability preserves your investment in existing CAD/CAE systems. Preserves the enormous effort that went into developing component libraries. Only CASE offers this advantage.

Unlike netlist interfaces, CASE's graphic interface allows you to re-display the same schematic on other CAD/CAE systems. Access to these schematics expedites design changes, logic simulation and PCB physical design. Only CASE has this capability.

Once you move your schematic to another system and make changes, you'll want to back-annotate. CASE provides a program that simplifies back-annotation between systems. With a basic "was-is" list, CASE can automatically update schematics. Only CASE provides this feature.

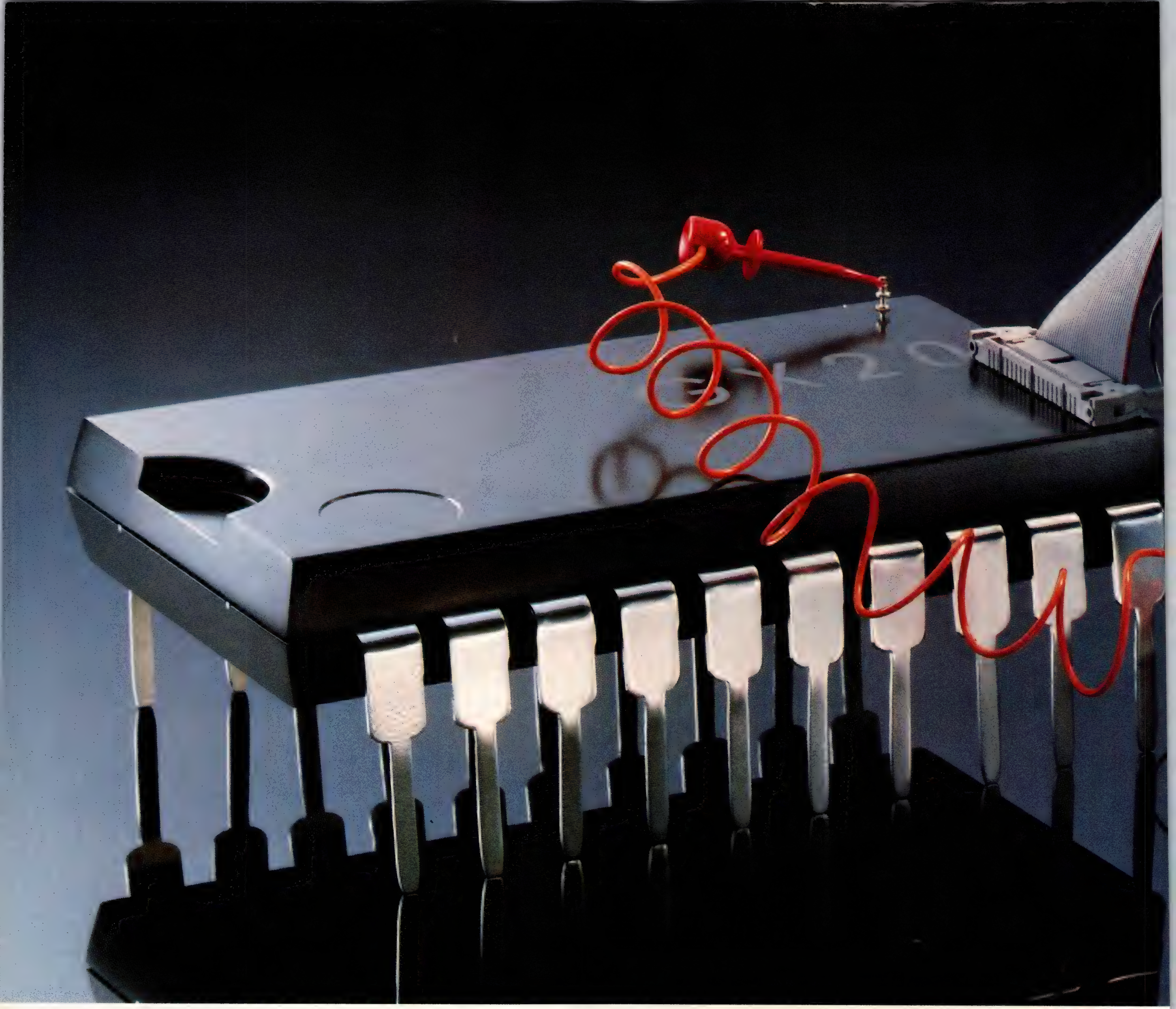
The CAE Price/Performance Leader

With more than 3000 installed systems, CASE Technology has developed a solid reputation as the CAE price/performance leader. What was once "the best kept secret in CAE" is now being touted throughout the world.

CASE Technology, Inc., 2141 Landings Dr., Mountain View, CA 94043. Phone: (415) 962-1440; FAX: 962-1466.

CASE TECHNOLOGY

CIRCLE NO 104



You wouldn't do this with your Analog VLSI devices.

You'll have to if you go to most ATE companies for a solution to today's sophisticated "system silicon" testing problems. Because all you'll get is a makeshift tester. And that means resigning yourself to man-months of custom hardware work integrating analog and digital instrumentation. And putting up with the long hours of low-level software development that go with custom solutions. Worse, you can expect these delays to cut your chances of getting your product to market on time.

Teradyne now has a simple answer to this complex testing problem. The A500 Analog VLSI Test System. It's the first of a new generation of systems specifically for AVLSI "system silicon" devices. A test system that can help you cut critical product development time by months or even years.

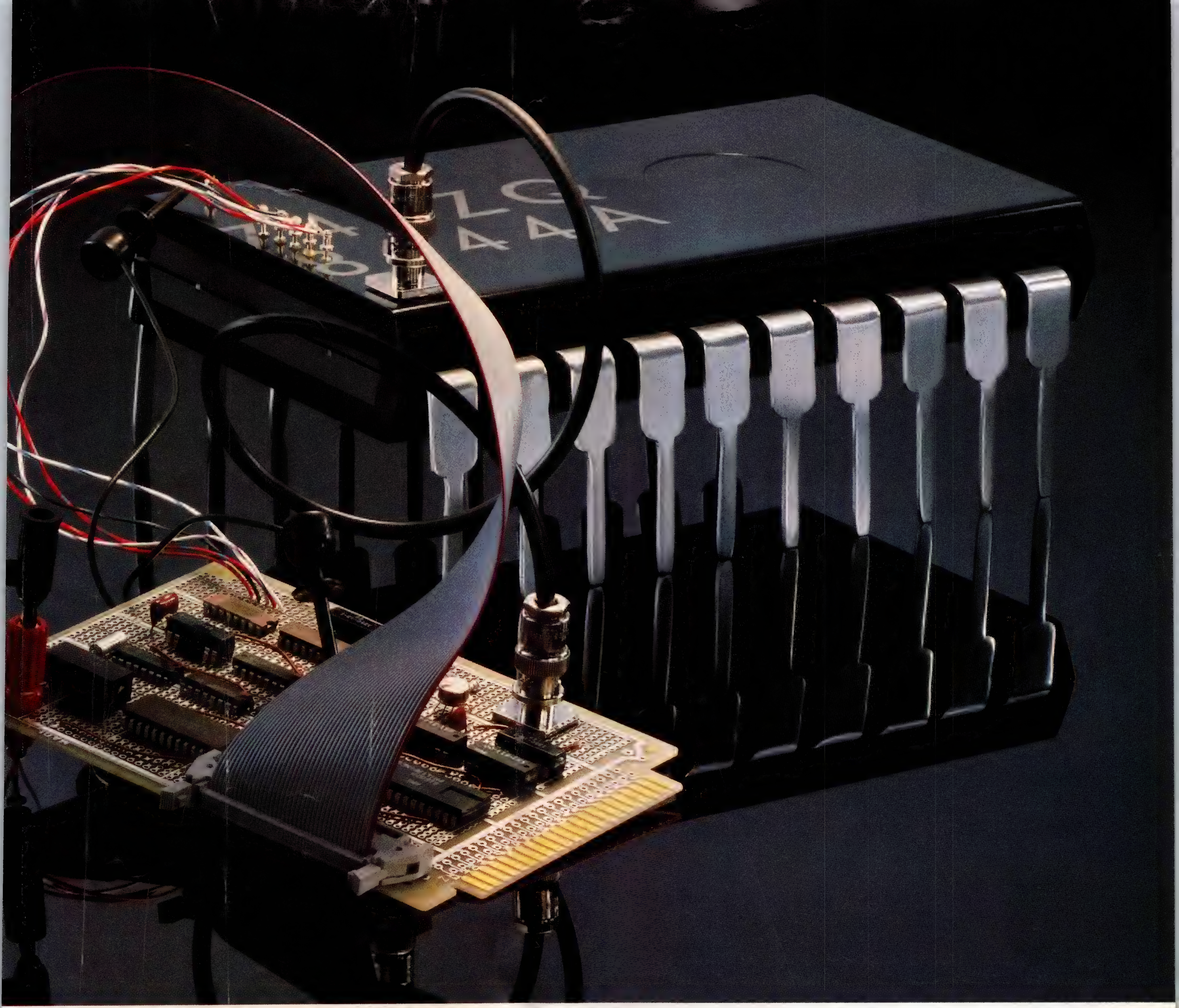
One Test System, Once and for All

With AVLSI devices you won't get fast design feedback, unless you test individual components—the "building blocks" of system silicon. And you won't comply with customer and industry requirements if you don't do complete "system" functional testing. With conventional test systems it means two of everything. Two testers, two test programs, two insertions, two data bases. And more than twice the time to get to market.

The A500 allows you to do it all with one system. So there's only one system to program. One insertion to make for both component and functional testing. And only one data base to work with. Which means significantly less time to market.

Vector Bus II™: the Great Integrator

The heart of the A500 is Teradyne's unique Vector Bus II architecture. It integrates analog and digital VLSI test capability at the system level. Which means you won't have to build special applications hardware for every new device you design. Vector Bus II eliminates that costly custom-work bottleneck



Why accept it in an Analog VLSI Test System?

with such features as TimeMaster™ Synchronization, Mixed-Signal Event Control, and MultiSource Data Mixing.

A Picture's Worth a Thousand Keystrokes
The A500 also revolutionizes program development. Our IMAGE™ (Interactive Menu-Assisted Graphics Environment) software gives you graphics programming as powerful as device designers' CAD/CAE tools. Using a mouse to control multiple windows, pop-up menus and software "power tools," you move ideas rapidly from mind to screen. And much faster to market.

Teradyne's new A500 is the only test system with the features you need to win the race for Analog VLSI market opportunities. To find out more, call Beth Sulak at (617) 482-2700, ext. 2746. Or call your nearest Teradyne sales office or write:
Teradyne, Inc., 321 Harrison Avenue,
Boston, MA 02118.

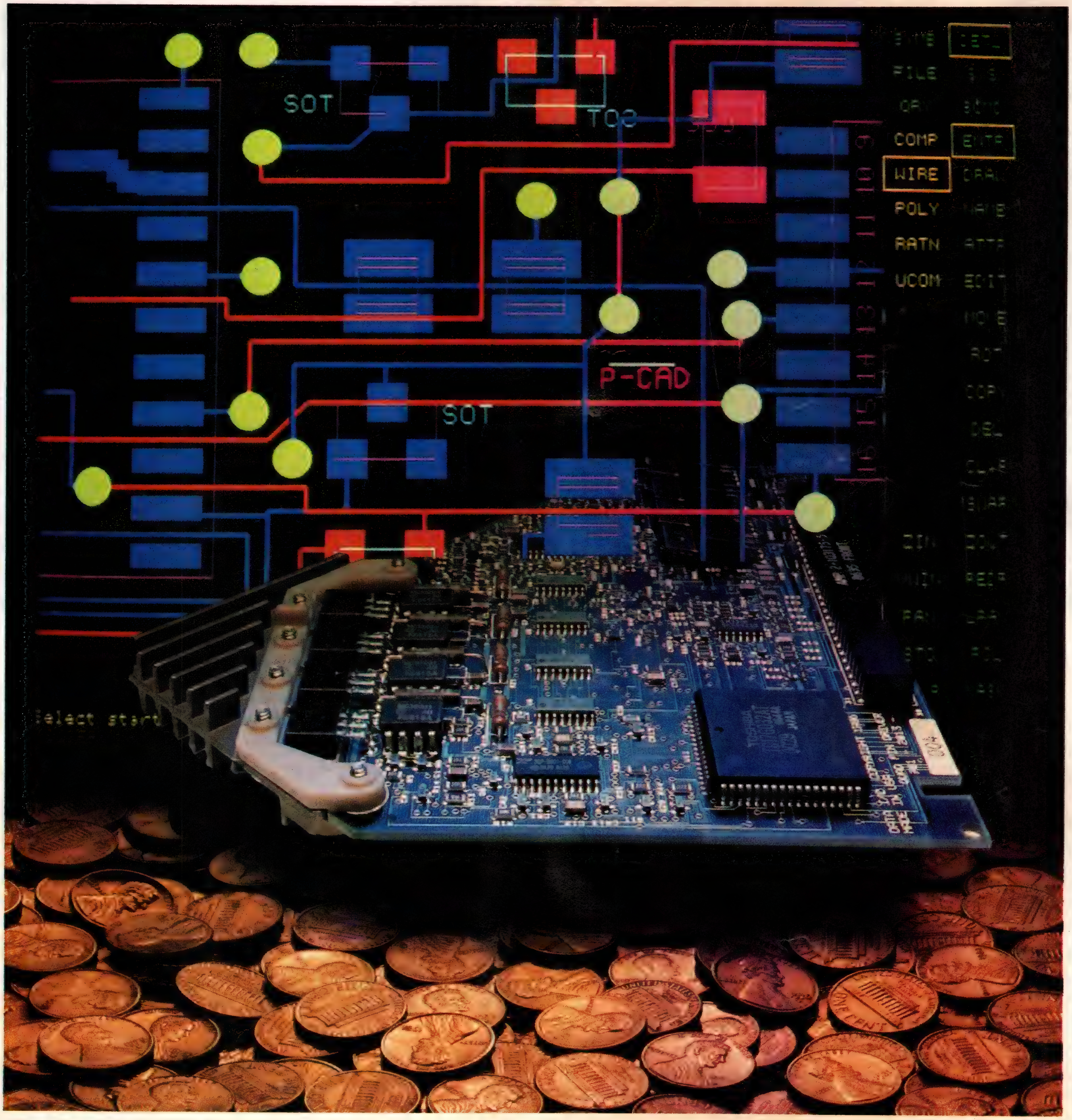
TERADYNE

We measure quality.

CIRCLE NO 106

Special Report

Low-cost pc-board



You won't get change back from your dollar *when you purchase pc-board layout software, but you can find capable packages that run on personal computers and that cost less than $15,000. (Photo courtesy Personal CAD Systems)*

Inexpensive programs can now complete pc-board layouts that once required mainframes or dedicated workstations. These programs, which typically run on personal computers, are automatic as well as interactive. You needn't use the packages often to become proficient with them—they're easy to learn and to use.

layout software

Eva Freeman, *Associate Editor*

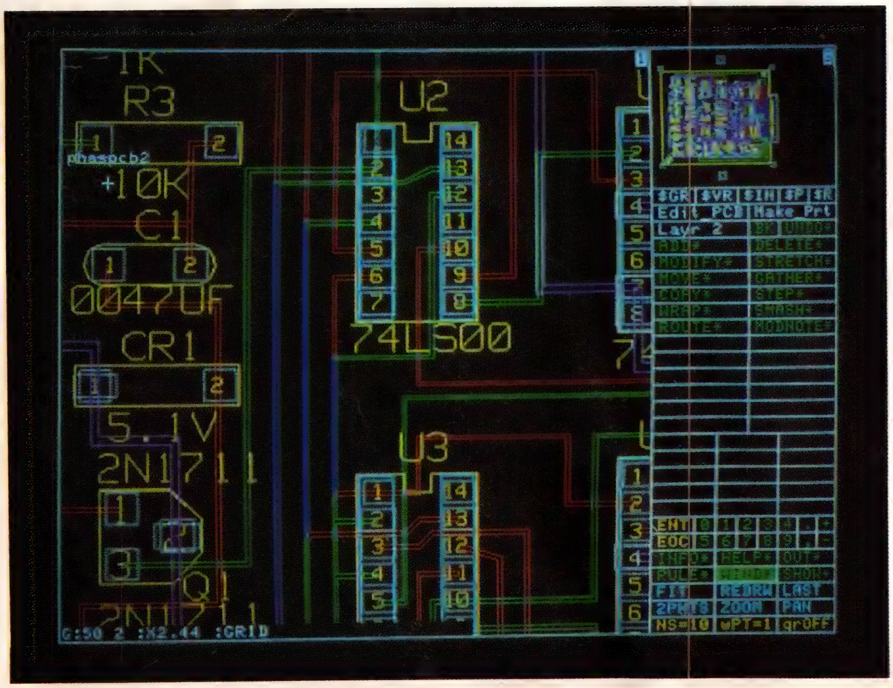
Advanced pc-board layout packages needn't be among the most expensive ones. In fact, for less than $15,000—in some cases much less—you can buy a layout package that can complete almost every pc-board design. Moreover, these programs are generally easy to use. Even if you have never laid out a pc board before, you can learn how to use a low-cost layout package quickly.

Until recently, you had to choose between sending your design to a pc-board service bureau or using a layout package that ran only on a dedicated workstation. CAD packages that cost less than $15,000 were drafting tools at best. However, today's low-cost pc-board layout software packages, most of which run on personal computers, generally provide the same features that workstation-based systems do. For example, most low-cost packages now offer optional autorouters. Because an autorouter draws interconnections automatically, you don't need layout experience to design your own board.

The autorouters in low-cost pc-board layout packages approach the sophistication of those in the most advanced workstation- or mainframe-based layout systems. For example, CAD Software's $750 Pads-Route autorouter provides three routers: power-and-ground, memory, and maze. The power-and-ground and memory routers specialize in power-supply and RAM interconnections; the maze router interconnects all other digital and analog components. However, the low-cost packages' autorouters don't match the speed of Calay's (Irvine, CA) V04 or Cadnetix's (Boulder, CO) CDX-75000 autorouters. Furthermore, low-cost autorouters can't consistently route all boards to 100% completion; the V04 and the CDX-75000 can.

Keep your expectations reasonable

Because the low-cost packages can't lay out boards as fast or as well as workstation- or mainframe-based software, you can't use a low-cost program for every design. Vendors of low-cost packages estimate that their programs can design about 80% of all pc boards. Therefore,



***Not all low-cost pc-board layout packages** run on general-purpose personal computers; Hewlett-Packard's Engineering Graphics System captures schematics and designs pc boards on the company's 32-bit workstation.*

Because an autorouter draws interconnections automatically, you don't need layout experience to design your own pc board.

before you commit your projects to a low-cost package, you must ascertain that such software is appropriate.

The low-cost packages' limitations are largely due to the limitations of the computers they run on. The MS-DOS operating system that the IBM PC uses, for example, can address only 640k bytes of memory. Thus, low-cost packages that run on IBM PCs and compatible computers can't handle databases of unlimited size.

You shouldn't expect, for example, to use a PC-based package to design an 8-layer, 500-IC board. Although several of the PC-based layout programs in **Table 1** (below) do permit eight layers and 500 components, the packages' autorouters can't route boards of such complexity. Furthermore, you'll usually find that the maximum number of traces limits your designs more than

TABLE 1—REPRESENTATIVE LOW-COST PC-BOARD LAYOUT PACKAGES

COMPANY	PRODUCT	BASE PRICE	REQUIRED HARDWARE	OPERATING SYSTEM	AUTO-ROUTER	AUTO-ROUTER PRICE
ABACUS SOFTWARE	PCBOARD DESIGNER	$195	ATARI 520ST OR 1040ST	GEM	●	
ACCEL TECHNOLOGIES	TANGO-PCB	$495	IBM PC/XT OR PC/AT	MS-DOS	●	
APTOS SYSTEMS	CRITERION II	$4000	ARTIST 1 CARD AND IBM PC/XT OR PC/AT	MS-DOS	●	$5000
AUTOMATED IMAGES	PERSONAL 870	$8000	IBM PC/XT OR PC/AT	MS-DOS		
B&C MICROSYSTEMS	PCB/DE	$395	IBM PC/XT OR PC/AT	MS-DOS (AND THE AUTOCAD DRAFTING PACKAGE)		
CAD SOFTWARE	PADS-PCB	$975	IBM PC/XT OR PC/AT	MS-DOS	●	$750
CASE TECHNOLOGY	VANGUARD PCB	$4250	IBM PC/AT, SUN-3, OR DEC MICROVAX	MS-DOS, UNIX, OR VMS	●	$5500
DAISY SYSTEMS	PERSONAL BOARDMASTER	$8000	IBM PC/AT OR DAISY PL386	DNIX		
DASOFT DESIGN	PROJECT: PCB	$950	IBM PC/XT OR PC/AT	MS-DOS	●	
DESIGN COMPUTATION	DRAFTSMAN–EE	$1147	IBM PC/XT OR PC/AT	MS-DOS	●	$2450
DOUGLAS ELECTRONICS	DOUGLAS CAD/CAM	$395	APPLE MACINTOSH	MACINTOSH		
ELECTRONIC DESIGN TOOLS	PROCAD	$2495	IBM PC/XT OR PC/AT AND 68000 COPROCESSOR	MS-DOS	●	$2495
ELECTRONIC INDUSTRIAL EQUIPMENT	EXECUTIVE CAD	$11,000	IBM PC/XT OR PC/AT	MS-DOS	●	
FUTURENET	DASH–PCB	$13,000	IBM PC/AT AND 32032 COPROCESSOR	UNIX	●	
HEWLETT-PACKARD	EGS	$7000	HP 9000	HP-UX		
KONTRON	KAD-286	$10,400	IBM PC/AT	MS-DOS		
PERSONAL CAD SYSTEMS	PCB-1	$6000	IBM PC/XT OR PC/AT	MS-DOS	●	$6000
RACAL–REDAC	REDBOARD	$12,000	IBM PC/XT OR PC/AT	MS-DOS	●	
SEETRAX (IN US, CIRCUITS AND SYSTEMS)	RANGER	$5000	IBM PC/AT	MS-DOS	●	$2000
SOFTCIRCUITS	PCLOPLUS	$1024	COMMODORE AMIGA 1000	AMIGADOS	●	
VAMP	McCAD	$395	APPLE MACINTOSH	MACINTOSH	●	$995
VISIONICS	EE DESIGNER II	$1875	IBM PC/XT OR PC/AT	MS-DOS	●	$1475
WINTEK	SMARTWORK	$895	IBM PC/XT OR PC/AT	MS-DOS	●	
ZIEGLER INSTRUMENTS (IN US, CADDY)	CADDY ELECTRONIC SYSTEM	$2495	IBM PC/XT OR PC/AT	MS-DOS	●	$2500

the maximum number of components or layers.

Table 1 lists the maximum number of traces that each package can handle, but note that vendors differ in the way they spec this capability: Some spec a maximum number of nets; others, a maximum number of lines. A net links all pins that are connected together; a line simply connects two points. (A line doesn't even necessarily connect two components; if a connection includes a 90° bend, some vendors consider the connection to be two lines.) A typical design contains roughly five lines per net. Thus, you can consider that a package that specs a 2000-net maximum is equivalent to one that specs a 10,000-line maximum.

The specs in **Table 1** can mislead you. Although a package might permit 1000 nets, 300 components, and 50 layers, you're better off avoiding the software limits.

	AUTO-PLACEMENT	COMPATIBLE NET LISTS	MAXIMUM NUMBER OF COLORS	MAXIMUM NUMBER OF TRACES	MAXIMUM NUMBER OF COMPONENTS	MAXIMUM NUMBER OF LAYERS	PACKAGING TECHNOLOGIES
			2	1100 LINES	250	2	
		ACCEL, OMATION, ORCAD	16	26,000 LINES	1000	9	SMD
	●	APTOS, FUTURENET, P-CAD	16	2000 NETS	1000	50	SMD, ECL, ANALOG
		APPLICON, FUTURENET, ORCAD	16			16	SMD, HYBRID
		B&C	16				
	●	FUTURENET	16	4511 NETS	764	30	SMD, FINE-LINE
	●	CASE	16	2000 NETS	1000	256	SMD
		DAISY	7	14,000 LINES	14,000	255	SMD
		DASOFT	6			4	SMD
	●		16	4000 NETS	300	20	FINE-LINE
			2				SMD, ANALOG
	●	ELECTRONIC DESIGN TOOLS	16	10,000 NETS	3000	56	SMD, CONSTANT-IMPEDANCE
	●	ELECTRONIC INDUSTRIAL EQUIPMENT	16			4	SMD, ECL
		FUTURENET	4			10	FINE-LINE
		HP	15			255	HYBRID
		KONTRON	64	5300 LINES	3200	255	ECL, SMD, HYBRID
	●	P-CAD, FUTURENET	16	1000 NETS	300	50	SMD
	●	RACAL–REDAC	16	1900 NETS	511	16	SMD
	●	SEETRAX	16	10,000 LINES	1400	16	SMD
			16				
	●	VAMP	2	32,000 LINES	32,000	6	SMD, METRIC
	●		16		999	26	SMD
		WINTEK	3			6	
		ZIEGLER	16			128	ANALOG

Vendors of low-cost packages estimate that their programs can design only about 80% of all pc boards, so you must ascertain that such software is appropriate.

As your design approaches the limits of the package, the software starts to run more slowly. Moreover, the autorouter generally fails to complete all the interconnections.

The 80386 µP will solve speed problems

You can accelerate most IBM PC-based layout packages simply by running them on an 80386-based personal computer. Most vendors of PC-based layout packages have written their software to run on generic PCs, and those programs can run on systems like the Compaq Deskpro 386. But even though a generic MS-DOS program runs faster on an 80386 µP than on a PC/XT or a PC/AT, a program that's written specifically for the 80386 could be even faster, deriving more benefit from the faster µP and the 32-bit bus.

The Personal Boardmaster 386, from Daisy Systems, is the first PC-based package that takes full advantage of the 80386. The system comprises pc-board layout software and a 386-based, $25,000 personal computer (made by Intel and available from Daisy). The computer includes a 16-MHz 80386 µP, a PC/AT bus, an 80287 math coprocessor, 4M bytes of RAM, and 53M bytes of hard-disk storage. A 17-in. monochrome display is standard, but you can select a 15- or a 19-in. color display.

The Personal Boardmaster 386 provides two operating systems: MS-DOS and DNIX. Because the $10,000 Personal Boardmaster 386 layout software doesn't run under MS-DOS, it isn't constrained by MS-DOS's memory limitations. Using this layout package, you can place as many as 14,000 components on your board. You can also draw as many as 14,000 lines and route a 255-layer design. You're obviously not going to place 14,000 components on a pc board or implement a 255-layer design, but you can be confident that the system won't slow down during any ordinary layout.

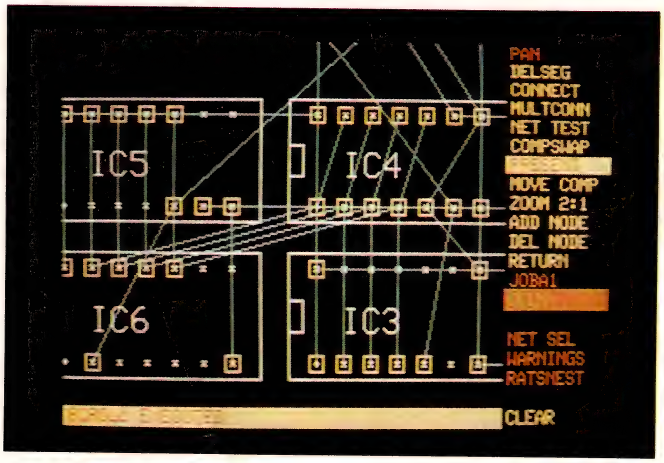
Daisy sells a PC/AT-based version of its pc-board layout software, Personal Boardmaster. This package runs at about half the speed of the 386-based system, but the slower package costs only $8000; the hardware starts at $20,000.

MS-DOS accepts extended-memory boards

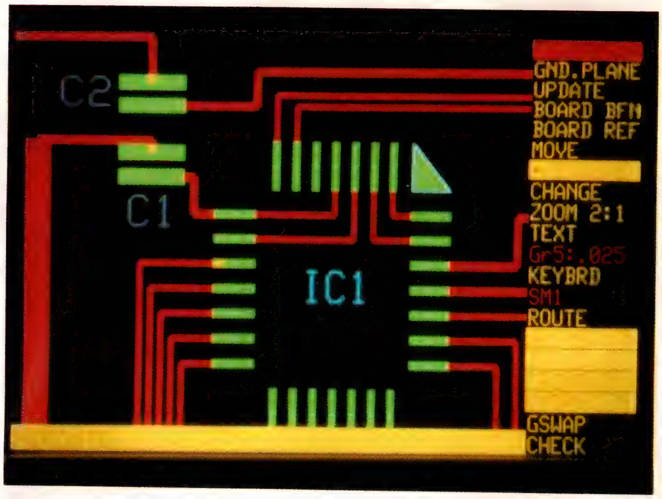
PC-board layout programs that run under MS-DOS usually cost less than software that runs under specialized operating systems. Furthermore, you can transfer data more easily among MS-DOS programs than among programs that run under incompatible operating systems. But if you want to run your software under MS-DOS, you must deal with MS-DOS's 640k-byte memory limitation.

To overcome this limitation, you might consider using an extended-memory board. Most PC-based layout packages can't yet take advantage of extended memory, but Case's and CAD Software's programs can use extended memory. CAD Software's $250 Pads-Large-SW option increases the maximum number of components from 539 to 764. This option also increases the number of connections from 2711 to 4511.

The addition of extended memory to Case's Vanguard program permits the system to complete pc boards that



A rat's-nest display, *such as the one provided by Electronic Industrial Equipment's Executive CAD package, can help you minimize the total length of interconnections in a layout.*



Even the most inexpensive packages *can handle sophisticated packaging techniques. Because the EE Designer II from Visionics can place components on both sides of a board, the package can lay out surface-mount designs.*

contain as many as 200 equivalent ICs. Without extended memory, the program can handle only as many as 125 equivalent ICs. In the next year, you'll be seeing many more layout packages using extended memory.

Plug-in cards accelerate PCs

You can also increase the speed and memory of a PC-based layout package by accelerating the PC. For example, Electronic Design Tools' Procad system includes a Motorola 68000-based coprocessor card. The 68000-based card, which includes 1M byte of RAM, costs $1595; the software starts at $2495.

Procad requires its own graphics card, which costs $1495 and features an 800×600-pixel resolution as well as a direct 68000 access port. In contrast to Procad's graphics card, a standard IBM Enhanced Graphics Adapter (EGA) card provides only 640×400 pixels. You'll find the increased resolution of the Procad card especially useful for fine-line or large designs.

The benefits of adding an accelerator card and a graphics controller to an IBM PC are obvious: Your calculations run faster, and you can read your display more easily. But don't forget that these features aren't free. In fact, the least expensive product that most vendors of low-cost layout packages sell is the basic program. As the **box,** "Watch out for the hidden extras," explains, optional programs and hardware dramatically increase the cost of pc-board layout.

The extra cost of an accelerator card can be a worthwhile investment. By adding a 32032-based coprocessor card to an IBM PC, FutureNet has been able to port a workstation-based layout program to the IBM PC/AT. Even on the PC/AT, though, the company's Dash-PCB program doesn't run under MS-DOS; the coprocessor card provides the PC with the Unix operating system.

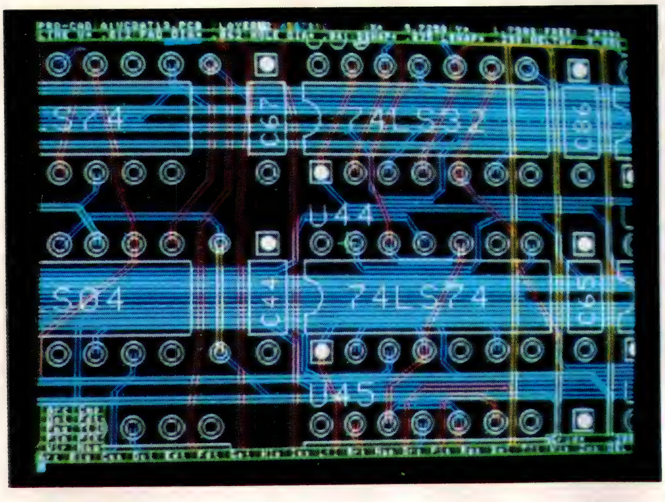
Dash-PCB layout software includes such features as 45° routing, fine-line layouts, and a multistrategy router. The package, which comprises software, the coprocessor card, and an 80M-byte hard disk, costs $13,000.

The best way to benefit from the memory-management features of Unix and the speed of a 32-bit bus is, of course, to run your software on a 32-bit workstation. But in general, workstation-based programs cost much more than PC-based programs. One exception to that rule is Hewlett-Packard's Engineering Graphics System. The package, which runs on Hewlett-Packard's 9000 Series 300 workstations, costs $7000. The workstations cost $15,000 to $25,000.

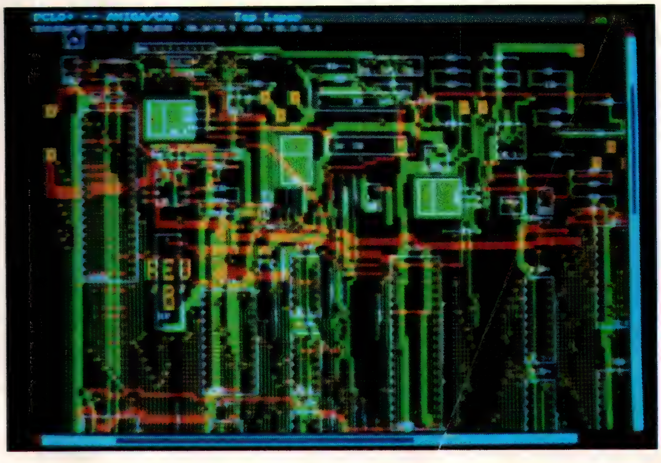
The architecture of the Engineering Graphics System lets you customize every module in the package. For example, you can adapt the bill-of-materials module to satisfy your company's purchasing requirements.

Bills of materials are a weak point in many pc-board layout packages. Although almost every program offers a bill-of-materials utility, these subroutines typically generate generic parts lists. Your purchasing department can't work with a request for a 10-kΩ resistor, however. You must also specify the wattage. Furthermore, many companies require internal part numbers in bills of materials, so a generic parts list might be useless.

In Hewlett-Packard's Engineering Graphics System,



By adding a 68000-based coprocessor card *from Electronic Design Tools to an IBM PC, you can run the company's Procad software as fast on the PC as you can on a 32-bit workstation.*



To encourage user improvements *to its pc-board layout package, Softcircuits provides the source code of its PCLOplus layout package. The program runs on Amiga computers.*

As your design approaches the limits of your package, the software starts to run more slowly, and the autorouter generally fails to complete all the interconnections.

you can associate design data and graphics data. Instead of just assigning a name to a part, you can link a symbol to as many design specifications as you need. The bill-of-materials program can handle as many as 20 specs, including part numbers and prices, for each part.

A $4000 option to the Engineering Graphics System lets you use the system for hybrid-circuit design. Using this program, you can generate thick-film resistors from resistor-paste curves and draw irregularly shaped conductors.

Such irregularly shaped conductors are important for analog circuits as well as for hybrids. Analog circuits require the irregular shapes for their ground planes. To create and fill polygons, you can use the Engineering Graphics System or even a lower-cost package like Aptos's IBM PC-based Criterion II.

Complex graphics for analog or dense digital circuits require greater resolution than an EGA card can generate. Therfore, Criterion II uses Control Systems' (St Paul, MN) Artist I card, which produces a 1024×768-pixel display. By controlling a 19-in. color monitor with this graphics card, your IBM PC's monitor can provide the graphics resolution of a CAD workstation. Criterion II costs $4000; the Artist I option lists for $1200.

Designs often require automatic layout

Good graphics are necessary to lay out a dense circuit, but graphics alone aren't sufficient. Unless you can boast of considerable experience in pc-board layout, you won't be able to route the interconnections on your

Watch out for the hidden extras

When you calculate the price of a pc-board layout package, don't forget to figure the options into your cost. Some vendors of low-cost pc-board layout software are like automobile manufacturers—they derive their profits from options, not from the basic package.

Unfortunately, you'll find that some optional programs really aren't optional. For example, Design Computation's basic Draftsman-EE provides only a graphics editor, a component library, and bill-of-materials and parts-list utilities. To generate a rat's-nest display and to check for design-rule violations, you must purchase the optional DC/Check program. The autorouter is yet another option. But you usually need these options for your pc-board layouts.

Draftsman-EE cost $749, DC/Check costs $398, and the autorouter lists for $2450. For $4000, you can purchase all of these tools, as well as 12 months of telephone assistance. Although $4000 certainly is a modest price for a complete pc-board layout system, it is more than five times the cost of the basic program.

Options can also cause sizable changes in the price of the more expensive of the low-cost packages. Compare, for example, the price of the PCB-1 and the Redboard pc-board layout packages. Personal CAD charges $6000 for PCB-1; Racal-Redac charges $12,000 for Redboard. Redboard includes autorouting and autoplacing software, however, and PCB-1 does not. P-CAD charges $6000 for its autorouting and autoplacing package. Thus, if you need an autorouter, you pay the same amount for either program.

(Racal-Redac's and Personal CAD's complete design packages, which combine automatic pc-board layout and schematic capture, also feature similar price tags. Personal CAD's PCB-3 costs $15,950; Racal-Redac's Redcad costs $14,900.)

You can buy a pc-board layout package for as little $95. This product, sold by Douglas Electronics as Douglas CAD/CAM and by Bishop Graphics as Quik Circuit, doesn't provide automatic-layout features or schematic capture. Furthermore, the program doesn't include interfaces to pen plotters or photoplotters. To use the $95 package, you must transmit your layout to Douglas or Bishop and have them fabricate your pc board, or you must buy the $300 pen-plotting option or the $500 combined pen-plotting and photoplotting option.

Options, especially for packages that list for less than $1000, greatly increase the total price of pc-board layout software. Nonetheless, the total cost is far less than the cost of a pc-board service bureau or a workstation-based layout system. Just remember the advice of the US Postal Service: "If an offer sounds too good to be true, it probably is."

1

Discover the Power of Integrated CAE Design Capture and Verification.

IN A SERIES

Tektronix Aided Engineering

Finding the most powerful electronic design solutions is now easier than ever, thanks to the Designer's WorkSystem.™

Developed by Tektronix as part of Tektronix Aided Engineering, the Designer's WorkSystem combines design capture and verification tools into one powerful solution.

Designer's Database Schematic Capture (DDSC™) provides you with a fast, user-customizable, menu-driven system for design capture of IC and PCB schematics.

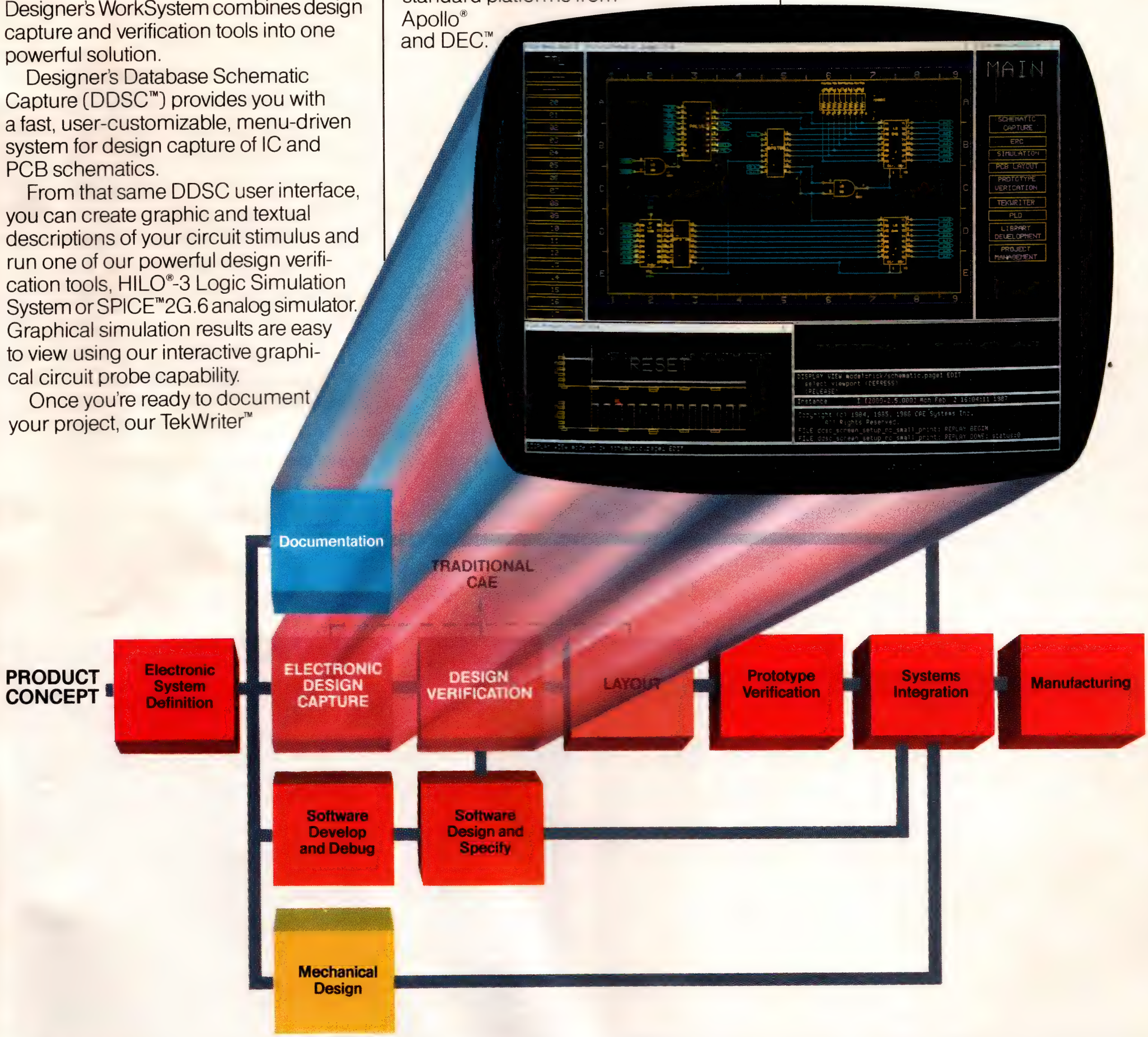
From that same DDSC user interface, you can create graphic and textual descriptions of your circuit stimulus and run one of our powerful design verification tools, HILO®-3 Logic Simulation System or SPICE™2G.6 analog simulator. Graphical simulation results are easy to view using our interactive graphical circuit probe capability.

Once you're ready to document your project, our TekWriter™ Engineering Design Documentation System (based on Interleaf™) lets you merge DDSC design schematics and simulation data with professional text formats and other graphics for fast, camera-ready documentation.

It's all part of Tektronix Aided Engineering. A family of integrated WorkSystems addressing each area of your electronic design cycle. From design capture, verification and documentation to IC and PCB layout. All running on industry-standard platforms from Apollo® and DEC.™

Best of all, it's from Tektronix. The name you've always trusted to get the engineering job done. So you're assured of worldwide service, support and training.

To discover the power of Tektronix Aided Engineering, contact your local Tektronix, CAE Systems Division, sales office. Or call 800/547-1512. Tektronix, CAE Systems Division, 5302 Betsy Ross Drive, P.O. Box 58137, Santa Clara, CA 95052-8137.



WorkSystem, DDSC, TekWriter are trademarks of Tektronix, Inc. HILO is a registered trademark of GenRad, Inc.
SPICE is based on Berkeley SPICE, University of California at Berkeley Interleaf is a trademark of Interleaf, Inc.
Apollo is a registered trademark of Apollo Computers, Inc. DEC is a trademark of Digital Equipment Corporation

Tektronix®
COMMITTED TO EXCELLENCE

CIRCLE NO 107

The benefits of adding an accelerator card and a graphics controller to an IBM PC are obvious: Your calculations run faster and you can read your display more easily.

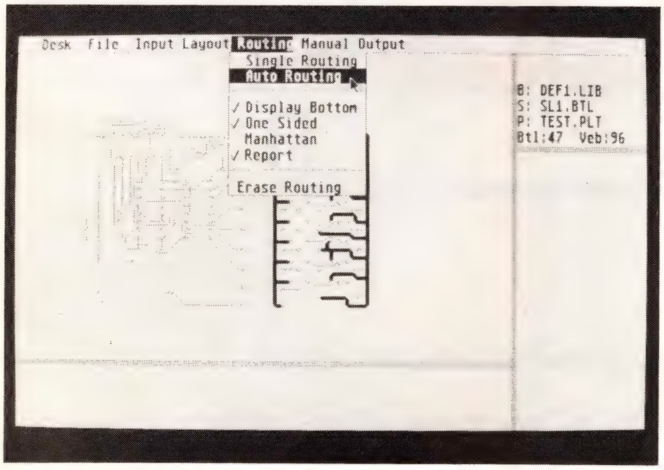
board without an autorouter **(Ref 1).**

An automatically routed layout, however, can be only as good as the component placement permits. If you don't optimize the placement of components on your board, your board will have more vias and longer interconnections than should be necessary. In many cases, the autorouter will simply fail to route the board completely. And in all cases, pc-board fabrication costs will be higher and system speed will be lower than they could be.

Most pc-board layout systems include a rat's-nest utility that can help you optimize the component placement. A rat's nest displays straight-line connections between components. Using a rat's nest, you can shift components on your layout and minimize the average length of interconnections.

Unless your layout is comparatively simple or you are an experienced pc-board designer, you won't obtain the best possible layout just by optimizing a rat's nest. "Rat's nest" is an appropriate name—the tangle of lines can be difficult to unravel.

Several low-cost pc-board layout packages, such as Racal-Redac's Redboard, now provide an automatic alternative to manual placement. You'll find two automatic-placement routines in Redboard. The first minimizes the total length of interconnections by rearranging the components on the layout. The second minimizes interconnection lengths further by adjusting the position of all DIPs on a board. The package also optimizes component placement by swapping logically equivalent gates or pins. By minimizing the length of interconnections, the automatic-placement software simplifies the autorouter's task.



```
B: DEF1.LIB
S: SL1.BTL
P: TEST.PLT
Btl:47  Veb:96
```

Interconnecting a design with 45° routing *can shorten many routing paths. Abacus Software's PCBoard Designer, which runs on Atari ST computers, features 45° routing in a low-cost package.*

If, after Redboard has optimized the position of board components, you see a way to improve the placement, you can move or rotate components interactively. Including automatic placement and routing, Redboard costs $12,000. You can also add schematic capture to Redboard; the schematic-editor option costs $2900.

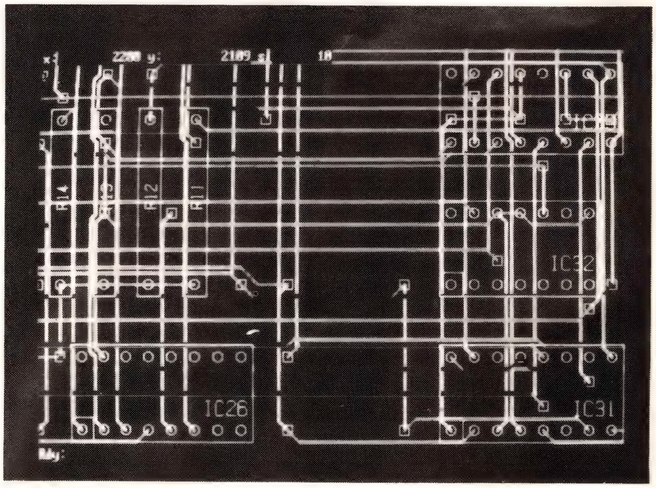
Feel free to include SMDs in your board

Automatic layout tools in low-cost packages enable you to implement advanced packaging technologies on your PC. For example, Personal CAD has just added features for SMD layout to its PCB-1 layout program. Because SMDs don't have leads that extend through a board, the program lets you place components on both sides of a board. The program also permits buried vias (vias that don't extend through all layers of a board).

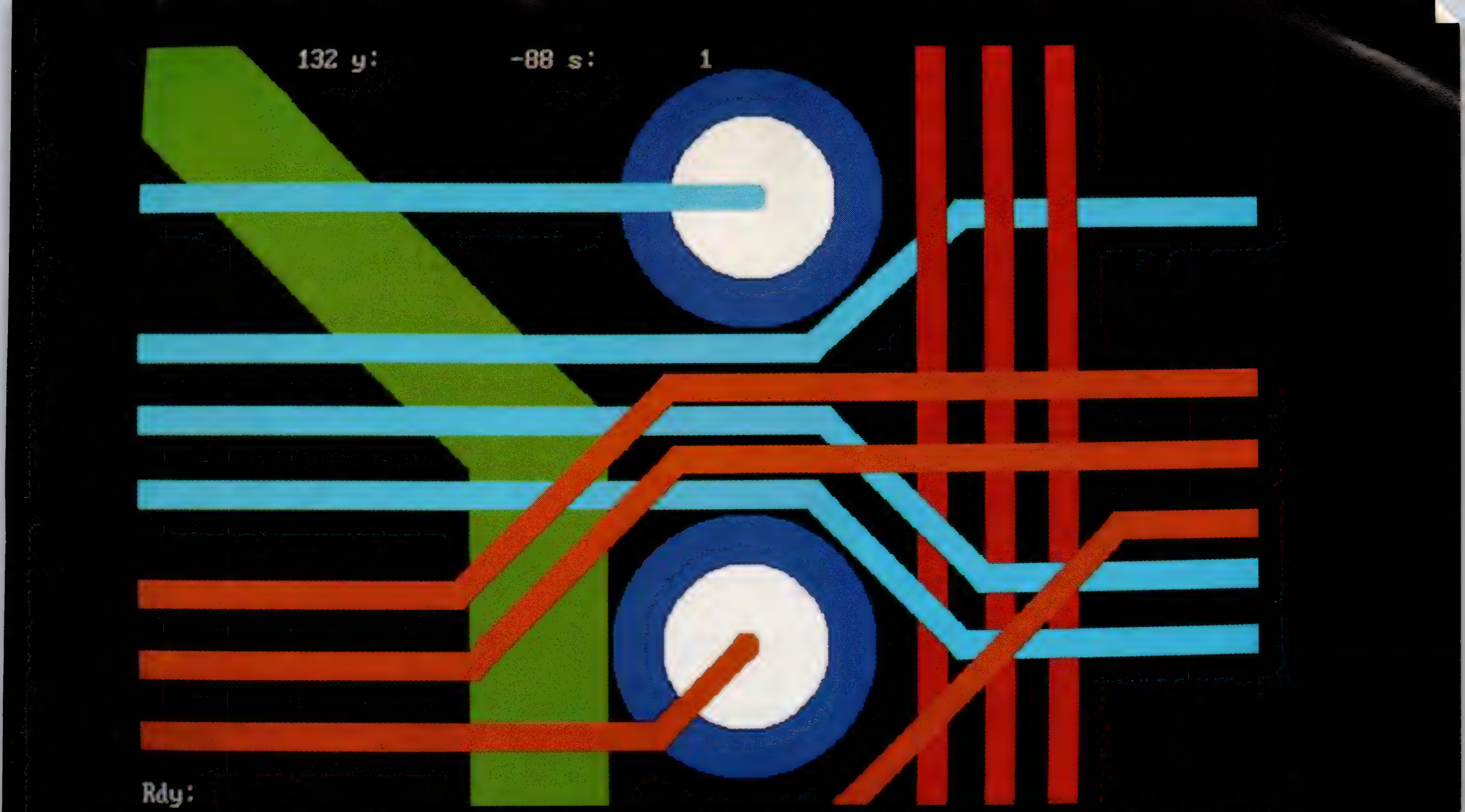
A library of SMDs rounds out PCB-1's tools for designing with surface-mount components. The SMD library features TTL, CMOS, discrete, and linear components. PCB-1 costs $6000. The company's PCB-3 package, which combines PCB-1, automatic placement and routing, and schematic capture, costs $15,950.

If you're a typical user of low-cost pc-board layout software, your design needn't accommodate advanced packaging technologies or implement sophisticated layout algorithms. All you need is an inexpensive package that's easy to use.

Several of the least expensive products run on per-



Vias increase fabrication costs *and decrease production yields, so the via-minimization algorithms in Design Computation's Draftsman EE automatic-layout package will give you an immediate return on your investment.*



Pictured above is a DRAFTSMAN-EE™ screen of a four-layer board routed by DC/AUTOROUTER II™. The blue circles represent outer layer pads while the white circles represent inner layer pads. The one-mil diagonal DC/AUTOROUTER II™ makes the most of any routing situation putting as many traces between pads as your design rules allow. The professional straight-line routing is a result of the final via minimization and route-straightening pass.

1-Mil. Diagonal. Powerful. High Capacity.

THE DC/AUTOROUTER II PRICED AT $2,450*

HIGH COMPLETION RATE

The field-proven DC/AUTOROUTER II™ is a high-end, professional autorouter for IBM personal computers and compatibles. With its low-cost, true diagonal autorouting and typical completion rate of 93-98%, DC/AUTOROUTER II™ clearly outperforms the competition.

FEATURE-PACKED

DC/AUTOROUTER II™ automatically generates a drill hole tape file and drill hole, solder masks, and silk screen art masters. The totally re-entrant DC/AUTOROUTER II™ can be interrupted and restarted with no loss of work. And parameters allow routing to be tailored to your specific needs.

COST SAVING

DC/AUTOROUTER II™ saves you money three ways:

1. Reduced board routing costs
2. Reduced board manufacturing costs over competitive autorouters
3. Reduced up-front costs by not requiring expensive, dedicated hardware.

DC/AUTOROUTER II™'s sophisticated via minimization pass produces lower cost boards than competitive autorouters that cost several thousand dollars more.

PLENTY OF POWER

DC/AUTOROUTER II™ boasts high-end power. Designed specifically for autorouting large, dense commercial boards, DC/AUTOROUTER II™ supports well over 350 ICs per board. And DRAFTSMAN-EE™, our graphics editor for schematic entry and board editing, is just as powerful. Built for the power-user,these products break the DOS 640 KB memory barrier by supporting EMS memory boards, yet the minimum memory requirement is just 512 KB.

MONEY-BACK GUARANTEE

DRAFTSMAN-EE™ and DC/AUTOROUTER II™ come with 60-day money-back guarantees. They run on industry standard personal computers, such as IBM and AT&T PCs as well as the COMPAQ DESKPRO 286 and 386.

The choice is simple: DC/AUTOROUTER II™—an outstanding autorouter at any price. Call today for more information: (201) 922-4111.

DC/AUTOROUTER II™ FEATURES

- 2 to 16-layer boards
- Any shape board up to 32"x 32"
- Over 350 ICs per board
- 1-mil "gridless" operation and placement
- True diagonal routing—an absolute must for medium to high density boards
- Powerful via minimization
- Sophisticated hugging and re-route algorithms for exceptional performance
- Common planes for power and ground
- Variable pad, via and drill hole sizes
- Variable route widths
- Single-layer and all-layer exclusion areas
- Arbitrary area fill
- Manual routing at any angle and any trace width before or after autorouting
- Thorough design rule checking and netlist comparison
- Pen plotter, Gerber photoplotter, or printed output

*Requires DRAFTSMAN-EE™ with manual routing option.

DESIGN
COMPUTATION

Design Computation, Inc.
Ten Frederick Avenue, Neptune, NJ 07753
(201) 922-4111 TWX: 510-601-8352

In **Australia & New Zealand**, contact Hypec Electronics (2) 808 3666, TELEX AA71551, In **Italy**, contact Eledra (02) 81821 TELEX 332332
In **France**, contact Generim 907 78 78, TELEX 691700F, In **Japan**, contact Teksel (03) 461-5121 TELEX 23723

CIRCLE NO 108

Bills of materials are a weak point in many pc-board layout packages; subroutines typically can generate only generic parts lists.

sonal computers that aren't compatible with IBM PCs. **Table 1** lists four such pc-board layout programs. The $195 PCBoard Designer from Abacus Software provides pc-board layout tools to Atari users. Softcircuits has brought pc-board layout to Commodore's Amiga; Softcircuits gives you the choice of the $500 entry-level PCLO program or the $1024 PCLOplus package, which runs faster than the less expensive version. Apple Macintosh users can choose between two programs: Vamp and Douglas Electronics both offer packages that start at $395.

Nevertheless, most low-cost pc-board layout pack-

Manufacturers of low-cost pc-board layout packages

For more information on pc-board layout packages, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Abacus Software
Box 7219
Grand Rapids, MI 49510
(616) 241-5510
Circle No 650

Accel Technologies Inc
7358 Trade St
San Diego, CA 92121
(619) 695-2000
Circle No 651

Advanced Microcomputer Systems Inc
2780 SW 14th St
Pompano Beach, FL 33069
(305) 975-9515
Circle No 652

Aptos Systems Corp
4113 Scotts Valley Dr
Scotts Valley, CA 95066
(408) 438-2199
Circle No 653

Augat Inc
Box 1037
Attleboro, MA 02703
(617) 222-2202
Circle No 654

Automated Images Inc
53 Cummings Park
Woburn, MA 01801
(617) 933-1731
Circle No 655

B&C Microsystems
6322 Mojave Dr
San Jose, CA 95120
(408) 997-7685
Circle No 656

Bishop Graphics Inc
5388 Sterling Center Dr
Westlake Village, CA 91359
(818) 991-2600
Circle No 657

CAD Software Inc
Box 1142
Littleton, MA 01460
(617) 486-9521
Circle No 658

Caddy Corp
3401 Algonquin Rd
Rolling Meadows, IL 60008
(312) 394-7755
Circle No 659

Case Technology Inc
2141 Landings Dr
Mountain View, CA 94043
(415) 962-1440
Circle No 660

Circuits and Systems
Foot of Second St
East Rockaway, NY 11518
(516) 593-4301
Circle No 661

Control Data Corp
Box 0
Minneapolis, MN 55440
Phone local office
Circle No 662

Daisy Systems Corp
700 Middlefield Rd
Mountain View, CA 94039
(415) 960-6593
Circle No 663

Dasoft Design Systems
1827B Fifth St
Berkeley, CA 94710
(415) 486-0822
Circle No 664

Design Computation Inc
10 Frederick Ave
Neptune, NJ 07753
(201) 922-4111
Circle No 665

Douglas Electronics
718 Marina Blvd
San Leandro, CA 94577
(415) 483-8770
Circle No 666

Electronic Design Tools Inc
1509 Falcon St
Suite 103
DeSoto, TX 75115
(214) 224-2472
Circle No 667

Electronic Industrial Equipment SA
15 rue Marziano
Box 140
1211 Geneva 24
Switzerland
(022) 423260
Circle No 668

FutureNet
9310 Topanga Canyon Blvd
Chatsworth, CA 91311
(818) 700-0691
Circle No 669

Great Softwestern Co Inc
270 W Hickory St
Denton, TX 76201
(817) 383-4434
Circle No 670

Hewlett-Packard Co
3404 E Harmony Rd
Fort Collins, CO 80525
(303) 229-3800
Circle No 671

Kontron Electronics Inc
630 Clyde Ave
Mountain View, CA 94039
(415) 965-3505
Circle No 672

Kontron Messtechnik GmbH
Oskar-von-Miller-Strasse 1
8057 Eching
West Germany
(08165) 77550
Circle No 673

Modula Corp
1673 W 820 N
Provo, UT 84601
(801) 375-7400
Circle No 674

Personal CAD Systems Inc
1290 Parkmoor Ave
San Jose, CA 95126
(408) 971-1300
Circle No 675

QTech Inc
256 E Hamilton Ave
Campbell, CA 95008
(408) 370-3910
Circle No 676

Racal-Redac Inc
4 Lyberty Way
Westford, MA 01886
(617) 692-4900
Circle No 677

Racal-Redac Ltd
Tewkesbury,
Gloucestershire GL20 8HE
United Kingdom
(0684) 294161
Circle No 678

Seetrax Ltd
Unit 10, Rodney Rd
Portsmouth, Hampshire PO4 8SS
United Kingdom
(0705) 754-320
Circle No 679

Softcircuits Inc
401 SW 75th Terrace
North Lauderdale, FL 33068
(305) 721-2707
Circle No 680

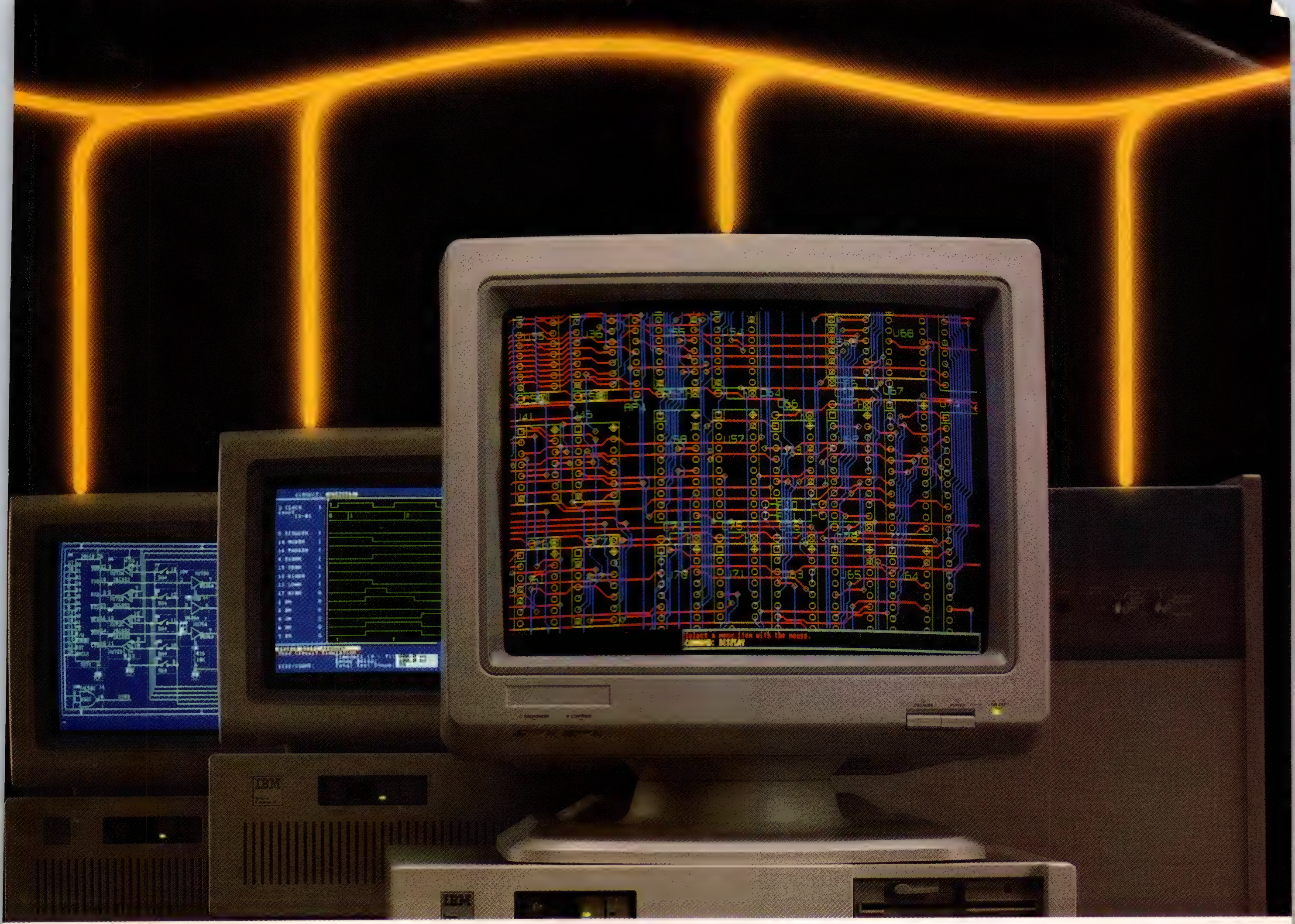
Vamp Inc
6753 Selma Ave
Los Angeles, CA 90028
(213) 466-5533
Circle No 681

Visionics Corp
1284 Geneva Dr
Sunnyvale, CA 94089
(408) 745-1551
Circle No 682

Wintek Corp
1801 South St
Lafayette, IN 47904
(317) 742-8428
Circle No 683

Wire Graphics
95 Sherwood Ave
Farmingdale, NY 11735
(516) 293-1525
Circle No 684

Ziegler Instruments GmbH
An der Waldesruh 17
D-4050 Monchengladbach 2
West Germany
Circle No 685



WHAT COULD YOU DO WITH A FUTURENET WORKSTATION?

What could you do with 32-bit computing power, the speed of a mainframe, and serious CAE software tools right on your desk? From schematic entry to simulation and circuit board layout, a FutureNet Workstation supports you throughout the entire design cycle. An open architecture and a modular upgrade path paves the way for future expansion. Yet, it's affordable enough to own today.

Network several workstations together and create a complete engineering environment that permits sharing of files and peripherals, and links to existing VAX systems.

With a FutureNet Workstation, your applications are unlimited.

ASIC DEVELOPMENT. You can develop programmable logic devices (PLDs), gate arrays, and other complex semicustom devices with your FutureNet Workstation. Capture designs graphically, functionally, or both. Only FutureNet gives you a choice. The workstation automatically performs logic synthesis, transforming your descriptions into schematics. Debug, refine and test with high-speed simulation capabilities.

ANALOG DESIGN. FutureNet handles analog design with equal ease. Advanced simulation techniques and highly accurate libraries help you improve circuit reliability and predict manufacturing yield before you build hardware.

PCB DESIGN. For both digital and analog portions of the board, the workstation offers powerful PCB layout and routing capabilities. Lay out circuit boards up to 32 × 32 inches and 10 layers deep in a fraction of the time it takes manually. A multi-strategy auto-routing system lets you choose from several sophisticated routines to optimize your circuit board.

Call us today, at (818) 700-0691. Once you've used a FutureNet Workstation, you'll wonder how you ever got along without it.

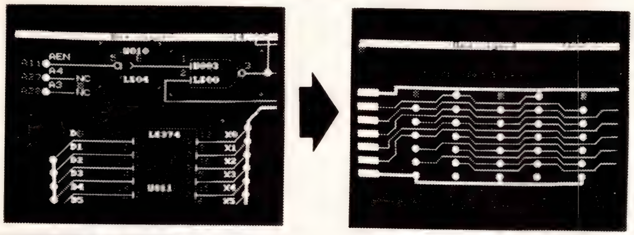
WHAT WOULD YOU DO WITHOUT IT?

FutureNet
A Data I/O Company

Data I/O Corporation 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. (206) 881-6444/Telex 15-2167
FutureNet 9310 Topanga Canyon Boulevard, Chatsworth, CA 91311-7528 (818) 700-0691/Telex 910-494-2681
Data I/O Canada 6725 Airport Road, Suite 302, Mississauga, Ontario L4V 1V2 (416) 678-0761/Telex 06968133
Data I/O Europe World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands (20) 622866/Telex 16616 DATIO NL
Data I/O Japan Sumitomoseimei Higashishinbashi Bldg., 8F, 2-1-7, Higashi-Shinbashi, Minato-ku, Tokyo 105, Japan
(03) 432-6991/Telex 2522685 DATAIO J

CIRCLE NO 109

Schematic to PC Layout
$350



SCHEMATIC CAPTURE $100

- A through D size drawing.
- 3 levels of zoom.
- uses keyboard and / or mouse
- User expandable library has over 1000 parts.
- Prints bill of material, net list (Futurenet, EDIF).

PC BOARD LAYOUT $250

- Board size 36 x 36
- 256 layers include silkscreen & solder mask.
- User definable pad and hole shape : sizes.
- Trace width .001 inch to 0.255 inch.
- Connectivity check with NETLIST.
- Optional autorouter $ 250 available soon.

Both packages support IBM PC with CGA, EGA & HGA graphics cards. IBM, Epson, Okidata printers and Hewlett-Packard, Houston instrument and all other plotters. **Demo Disk $ 10**

(305) 975-9515 ams **800-9PC-FREE**

ADVANCED MICROCOMPUTER SYSTEMS, INC.
2780 S.W. 14th Street Pompano Beach, FL 33069

CIRCLE NO 24

The Personal EPROM Programmer . . .

MODEL 9000
EPROM PROGRAMMER

- Adds (E)EPROM programming to your PC based development system
- Quick pulse and intelligent algorithms are supported
- PGMX software is DOS resident and installs in just minutes
- Programming support for currently manufactured devices . . . as well as many "TBA" devices!

Also available — Personal EPROM systems, OEM programmers, and production programmers/duplicators

DRAWER 1346
BAY ST. LOUIS, MS 39520

GTEK, INC.

601-467-8048

GTEK, PGMX, MS-DOS, PC-DOS are registered trademarks

CIRCLE NO 25

A point-to-point router assists *interactive pc-board design with Wintek's Smartwork program; an autorouter completes sections of board designs that don't require manual intervention.*

ages run on the IBM PC. Two vendors have held down the cost of their IBM PC programs by linking their software to Autodesk's (Sausalito, CA) Autocad drafting package. Because Great Softwestern's Auto-Board and B&C Microsystems' PCB/DE use Autocad as a drafting tool, the creators of the programs could focus their code on pc-board layout. Auto-Board, which includes schematic capture and automatic routing, costs $2495; PCB/DE costs $395.

Most PC-based packages supply their own drafting software. Wintek's $895 Smartwork program, for example, includes all the graphics tools you need for pc-board layout. To aid you in pc-board design, Wintek has recently added an $895 schematic-capture program and is now introducing an automatic router.

Visionics has recently added an automatic router to its EE Designer II pc-board layout package. The basic software costs $1875; the autorouter option increases the price by $1100. Besides 2-layer boards, the autorouter can route SMD and multilayer boards.

Multilayer capabilities notwithstanding, low-cost pc-board layout packages still don't match the speed or provide the quality of layout algorithms that traditional layout systems offer. If you give your PC the kind of layout problem that would challenge a mainframe or a 32-bit workstation with custom autorouting hardware, you'll be sorely disappointed. But if your pc boards fall among the 80% of designs that low-cost packages can complete, you'll find that pc-board layout has never been so inexpensive and so easy. **EDN**

Reference

1. Freeman, Eva, "Autorouters use sophisticated algorithms to lay out complex, multilayer pc boards," *EDN*, August 7, 1986, pg 67.

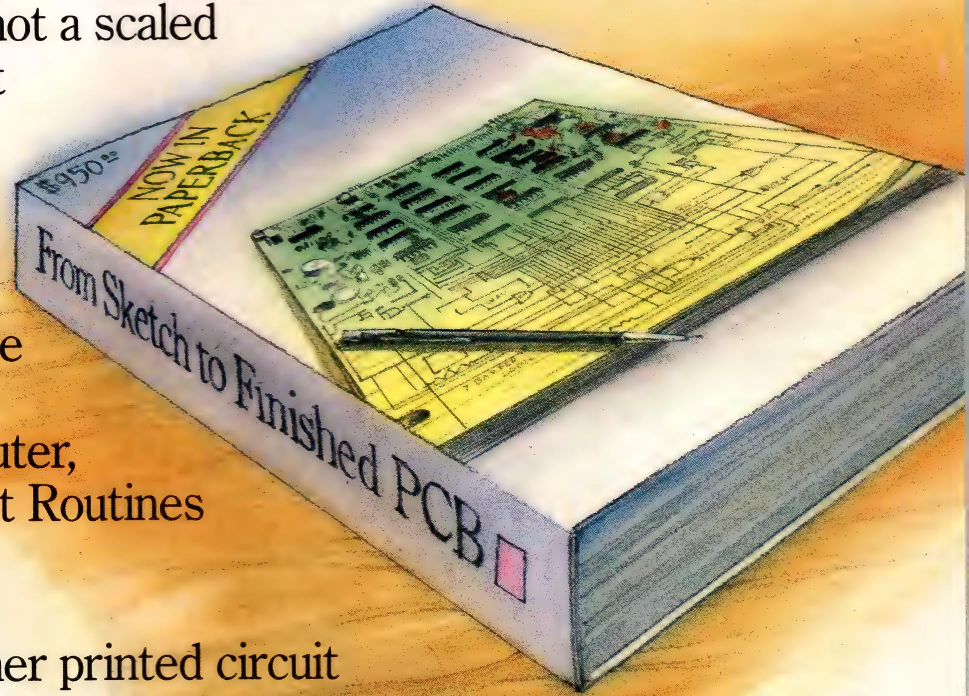
Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

PROJECT:

PCB

SOFTWARE FOR PRINTED CIRCUIT DESIGN

We like to think of it as our paperback edition. Project:PCB was developed by our engineers because we think you deserve a choice for your money; a real choice, not a scaled down version that can't quite handle the job.


$950⁰⁰
NOW IN PAPERBACK
From Sketch to Finished PCB

Project:PCB specs speak for themselves. The system is complete with Schematic Editor, Layout Editor, Autorouter, Library Managers, Plot Routines and Listing Routines.

At $950, there's no other printed circuit board design software available that matches Project:PCB for performance, thoroughness and price. You get a package that does the job—from design concept to board artwork.

To review Project:PCB for yourself, ask about our demo disk. All purchases are backed by our 30-day money-back guarantee. So order your copy of Project:PCB now—it's destined to be a best-seller.

DASOFT
DESIGN SYSTEMS, INC.
PHONE (415) 486-0856
P.O. Box 8088, Berkeley, CA 94707-8088

Project:PCB *sells for $950, and can be shipped immediately from stock. Terms are prepay, COD, VISA or MasterCard. The Project:PCB system runs under MS-DOS™ on the IBM®XT/AT (640K RAM and a minimum 10Mb Hard Disk) and compatibles. Graphics options include Hercules™ Monochrome (or compatible), CGA or EGA with monochrome monitor, and EGA with color monitor (add $300 for full color). A system mouse is required and a wide variety of plotters are supported. All Project:PCB editors are menu-driven.*

IBM is a registered trademark of International Business Machines Corporation. MS-DOS is a trademark of Microsoft Corporation. Hercules is a trademark of Hercules Computer Technology.

CIRCLE NO 110

THE PROGRAMMABLE GATE YOU'VE ALWAYS WANTED.

We don't mean to be wishy-washy, it's just that our Programmable Gate Array delivers both more of what you want and less of what you don't.

Unlike a conventional gate array which is cast in cement at the factory, the Programmable Gate Array is user-programmable. So there's no risk in design or inventory. And that makes it a lot less dicey.

As in, more speed and less money.

More density and less risk.

And more design flexibility but less time to market.

How can one part offer so much?

By combining the advantages of VLSI with the advantages of programmability. And eliminating the disadvantages.

"OF COURSE. A PROGRAMMABLE GATE ARRAY."

That's what logic designers said when we asked them if they could describe the ideal logic device.

We couldn't agree more. Just look at the benefits of such a device.

You get the wide open architecture of a gate array, without the penalties. The NRE, the long development time, the inventory risk, the limited testability, and last but certainly not least, the 50-50 chance that system changes may mean another pass.

Instead, you get programmability. Unlimited reprogrammability. No NRE. A development cycle you can measure on one page of a month-to-month calendar. And a standard part that arrives on your doorstep already tested 100% perfect down to the last transistor.

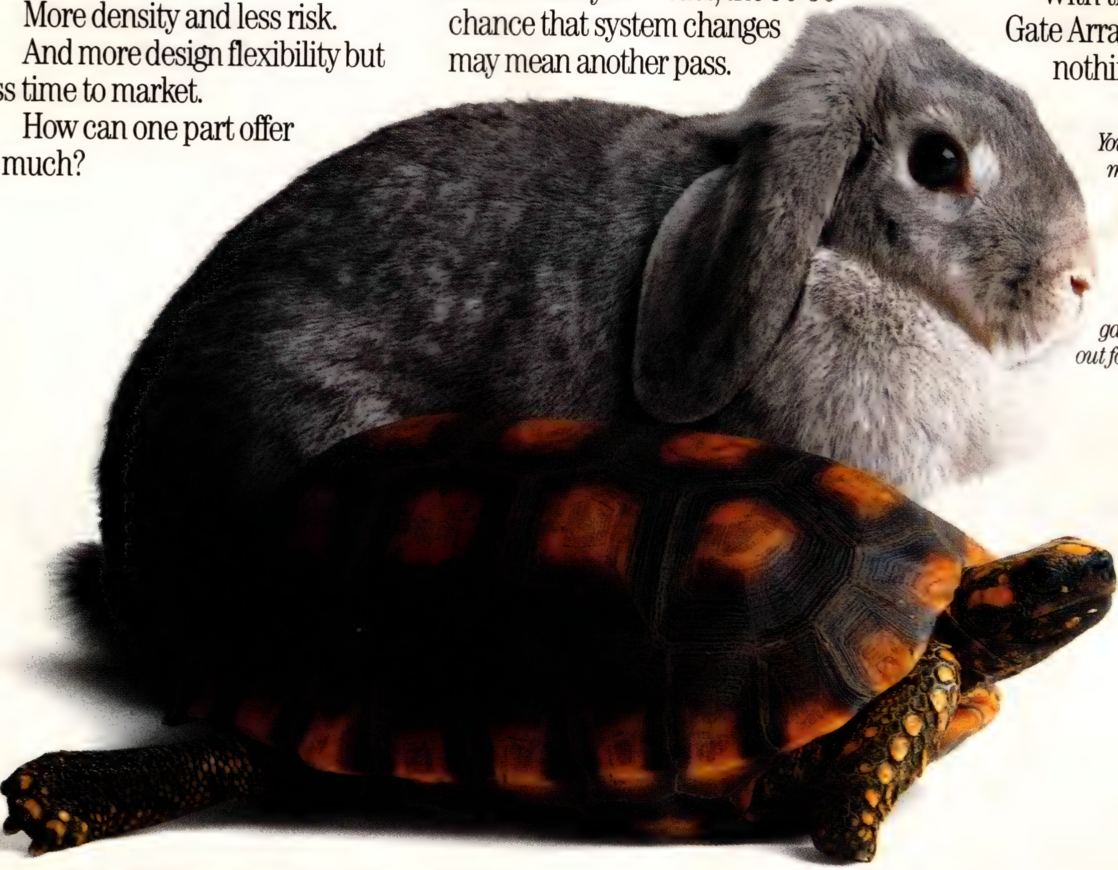
You can't beat it with a stick.

SPEED, DENSITY, PRICE. PICK ANY THREE.

Until the Programmable Gate Array, logic design was a frustrating game of give and take.

You gave up certain things as limited logic solutions took away your options.

With the Programmable Gate Array, you give up nothing.



You might not expect much speed in a part like this. But at 70 MHz, the Programmable Gate Array is more than fast enough for most applications. And with 1800 gates to work with, why shell out for a bunch of little PLDs?

Xilinx, Logic Cell, and XACT are trademarks and "The Programmable Gate Array Company" is a service mark of Xilinx, Inc. Other brand or product names are trademarks or registered trademarks of their respective holders. © 1986 Xilinx, Inc., 2069 Hamilton Ave., San Jose, CA 95125, (408) 559-7778.

ARRAY. IT'S JUST WHAT MORE OR LESS.

Does this picture remind you of a gate array? Perhaps if the bills were on fire. By comparison, there is no comparison. The Programmable Gate Array costs far less to develop. And nothing to change.

Let's look at logic design's Big Three: speed, density and price.

Our new Programmable Gate Array, the XC 2018, turns toggle rates of 70 MHz. And we've enhanced our original part, the XC 2064, to run just as fast.

There's more density, too. As promised, there are 1800 honest gates in the 2018. And thanks to our unique Logic Cell™ Array architecture, the magic number's going to be 8000 by year-end.

The price, however, is continuing to go down, just like the prices of other standard parts.

A FULL SET OF POWER TOOLS.

Everybody knows you can't do a good job without the right tools. So we offer everything you need.

We've connected with Future-Net™ to bring you their schematic capture capabilities, the most powerful and popular in the industry. To which we've added our own auto-place-and-route.

This, in addition to our already extensive integrated XACT™ development system. Complete with an interactive graphics-based, mouse-and-menu driven design editor, a simulator, and the logic industry's only in-circuit emulator. It runs real I/O in real time, so you get real design verification, *in the system.*

Every bit of the above runs on an IBM® PC/XT,™ PC/AT™ or clone. And you can get started for just $3600.

JUST TELL US WHAT YOU WANT.

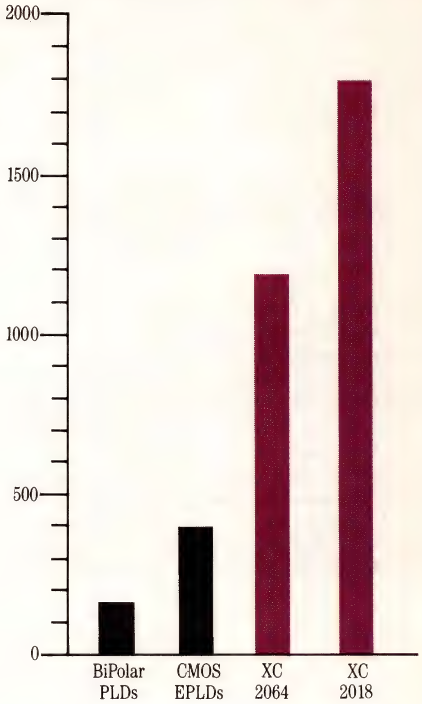
Like to see some more information so you can chew on it in the privacy of your home or office? We have a free design handbook that tells all.

Rather find out first hand what you can do with the Programmable Gate Array? Order our evaluation kit (affectionately known as EK-01). It has the software and documentation you'll need to evaluate your application on the Programmable Gate Array and see how it performs.

Better yet, why not get right down to business by talking with one of our field application engineers? They can answer any questions you might have. And you can get our application support right from the beginning.

All you have to do is call us. Toll-free at (800) 255-7778. In California, (408) 559-7778. Or contact your local Xilinx sales representative or Hamilton/Avnet distributor.

How many gates do you really get?



Other PLDs claim lots of gates, but their restrictive architectures only let you use a small fraction of them. Our patented Logic Cell Array architecture is more open. So you can use all the gates we claim. And there are more chips—with more gates—on the way.

After all, why use anything else when the Programmable Gate Array gives you so much more? And, so much less.

XILINX

The Programmable
Gate Array Company℠

CIRCLE NO 111

THE BEST Schematic Capture IS ONLY $495

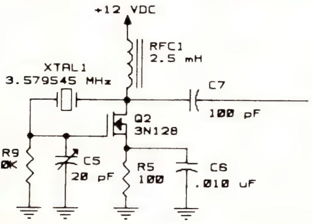
WHY SETTLE FOR LESS?

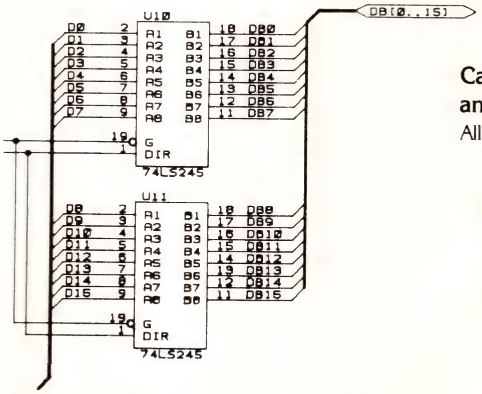
You get more with **OrCAD/SDT** than any other schematic capture program. At any price!

- Runs on IBM PC/XT/AT or compatibles
- Part Rotation and Mirroring
- Rubberbands Wires and Buses
- Supports **TRUE** A through E size sheets
- Unlimited Level Hierarchy, Keyboard Macros
- Step and Repeat, Auto Panning, 5 Zoom Levels
- Color and Monochrome Graphics
- Parts List, Design Check and Library Utilities
- Net Lists automatically generated in Algorex, Applicon, Calay, Cadnetix, Computervision, EDIF, FutureNet, Multiwire, PCAD, PSpice, Racal-Redac, Scicards, and Telesis formats!

At OrCAD we don't think you should have to struggle to create libraries. That is why we have included over **3000 UNIQUE** parts. With this many devices, libraries are obviously easy to create. Spend your valuable time creating designs instead of making new parts.

Why wait to turn your PC into a quality design tool? For only **$495** you will discover that **OrCAD/SDT** is the most complete and cost effective schematic design tool available.



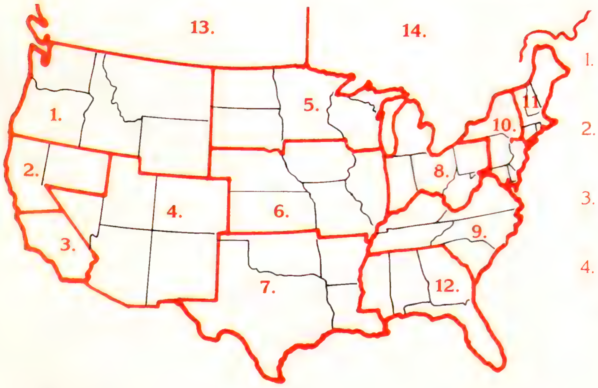


Call today to receive your Free Demo Disk and brochure.

All orders are shipped from stock!

OrCAD
Systems Corporation

1049 S.W. Baseline St., Suite 500
Hillsboro, OR 97123
(503) 640-5007
Telex: 9102402090 ORCAD UQ



Contact your OrCAD Representative
For Further Information

1. WA, OR, MT, ID, AK, WY
Seltech, Inc.
503-627-0716

2. N. CA, Reno NV
Elcor Associates, Inc.
408-866-5505

3. So. CA
Advanced Digital Group
714-897-0319

4. Las Vegas, NV, UT, AZ, NM, CO
Tusar Corporation
602-998-3688

5. ND, SD, MN, WI
Comstrand, Inc.
612-788-9234

6. NE, KS, IA, MO, IL
Walker Engineering, Inc.
913-888-0089

7. TX, OK, AR, LA
Abcor, Inc.
713-486-9251

8. IN, OH, KY, WV, W. PA, MI
Frank J. Campisano, Inc.
513-574-7111

9. TN, NC, SC, VA
Tingen Technical Sales
919-878-4440

10. E. PA, NJ, NY, DE, MD, DC
Beta Lambda, Inc.
201-446-1100

11. CT, RI, MA, VT, NH, ME
DGA Associates, Inc.
617-935-3001

12. MS, AL, GA, FL
High Tech Support
813-920-7564

13. BC, AB, SK, MB
Interworld Electronics &
Computer Industries, Ltd.
604-984-4171

14. ON, PQ
Electralert
416-475-6730

OR-8701

CIRCLE NO 112

The first choice in plotting.

First in monochrome. Versatec invented the wide format electrostatic plotter in 1974. Three generations later, Versatec plotters are still the fastest, most accurate, most reliable of all monochrome electrostatics.

Only Versatec offers 200 and 400 ppi resolution in plotting widths of 22, 24, 36 and 44 inches. Get paper and film output, twin roll media supply, "plug-in anywhere" international power supply, and lowest operating costs.

And only Versatec gives you all these options – high accuracy (± 0.01%), automated media cutter, tilt to 15 degrees, line enhancement, and hardware character generator.

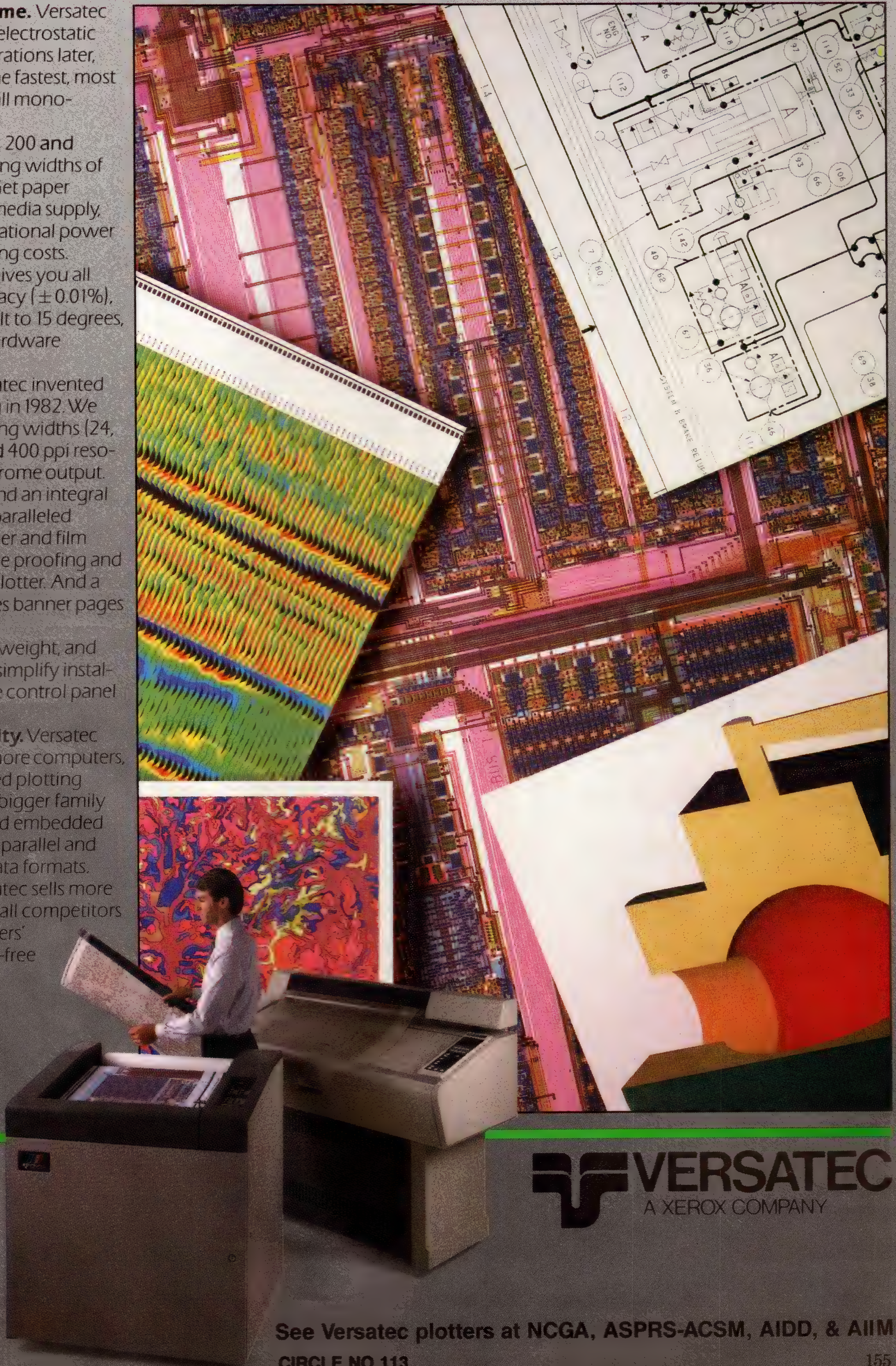
First in color. Versatec invented electrostatic color plotting in 1982. We give you a choice of plotting widths (24, 36 and 44 inches), 200 and 400 ppi resolution, and color/monochrome output.

Dual axis tracking and an integral alignment pass assure unparalleled accuracy. High quality paper and film with mirror imaging enable proofing and final output on the same plotter. And a character generator creates banner pages quickly and efficiently.

Compact size, light weight, and low power requirements simplify installation. And an easy-to-use control panel simplifies operation.

First in connectivity. Versatec offers more interfaces to more computers, a larger library of integrated plotting software packages, and a bigger family of modular standalone and embedded rasterizers accepting both parallel and industry-standard serial data formats.

Discover why Versatec sells more electrostatic plotters than all competitors combined. Circle the readers' service number or call toll-free 800/538-6477.*



*In California, call toll-free 800/341-6060

Versatec is a trademark of Versatec, Inc.
Xerox is a trademark of Xerox Corporation.

Plot data courtesy of Intergraph Corporation, Uniras and Zeh Engineering Systems

VERSATEC
A XEROX COMPANY

See Versatec plotters at NCGA, ASPRS-ACSM, AIDD, & AIIM

CIRCLE NO 113

Let Douglas Electronics Introduce You To CAD/CAM For Just $95

The circuit boards in this ad were all manufactured at Douglas Electronics from designs created on the Douglas CAD/CAM System. Many of them were returned to their designers three days after layouts were completed. With Douglas CAD/CAM, you get more than just a layout system. You get a manufacturing system as well.

This integration of design and manufacturing into one system is what makes Douglas CAD/CAM different from all other CAD packages on the market. The end result of a layout on the Douglas System can be an actual circuit board - not just a pen plot or a piece of film. That's a timesaver. That's a total concept. That's the Douglas CAD/CAM System.

Douglas CAD/CAM is so easy to learn and use that you can design your first board the same day you receive the software. Layouts can be as large as 32" x 32", and multilayers are supported. The software provides a variety of lines, pads and holes. You have the flexibility to use these preset elements or to customize every item to your specific design needs. User-definable grids and fifty different view scales allow you to work with precision on detailed areas of your board.

Fabrication can begin immediately after you complete your layout. Simply transfer your design file via modem or mail to Douglas Electronics. We send you the finished boards in return. Take advantage of our three-day delivery for those jobs you needed yesterday.

Douglas CAD/CAM requires no special hardware. The fast, high resolution Apple Macintosh is all you need.

Available in three versions, Douglas CAD/CAM has output capabilities to printers, photoplotters, and pen plotters. But we think you'll agree that circuit boards made directly from the system are the best form of output possible.

Isn't It Time You Got Introduced To CAD/CAM?

DOUGLAS CAD/CAM System

DOUGLAS ELECTRONICS
718 Marina Blvd.
San Leandro, CA 94577
(415) 483-8770

CIRCLE NO 115

Get inside the 8051!

Developing products based on the 8051 microcontroller? Then you'll be very interested in our **MAB** (microcomputer adapter box) **80C51**.

Because, used with any of our development systems (PEDS, PMDS-2 or PMDS-3) it actually gets you inside the 8051 chip by providing total access to all internal features.

The **MAB-80C51** allows full real time transparent emulation for 8051, CMOS, NMOS and HMOS microcontrollers plus selected derivatives.

Power down and idle modes are supported and special bonded out lines provide access to program and data memories. You can also break program execution and "freeze" the CPU status (including timer and interrupt levels).

Moreover, the **MAB-80C51** is complemented by a powerful range of cross software and symbolic debuggers, including a PL/M-51 compiler supported on VAX, IBM PC-AT, PEDS and PMDS hosts.

Test the difference

And as Philips is one of the world's leading manufacturers and users of microcontrollers, microprocessors and development tools, you benefit by choosing a single-source supplier who understands your needs perfectly.

VAX – Digital Equipment Corp.
IBM PC – International Business Machines Corp.

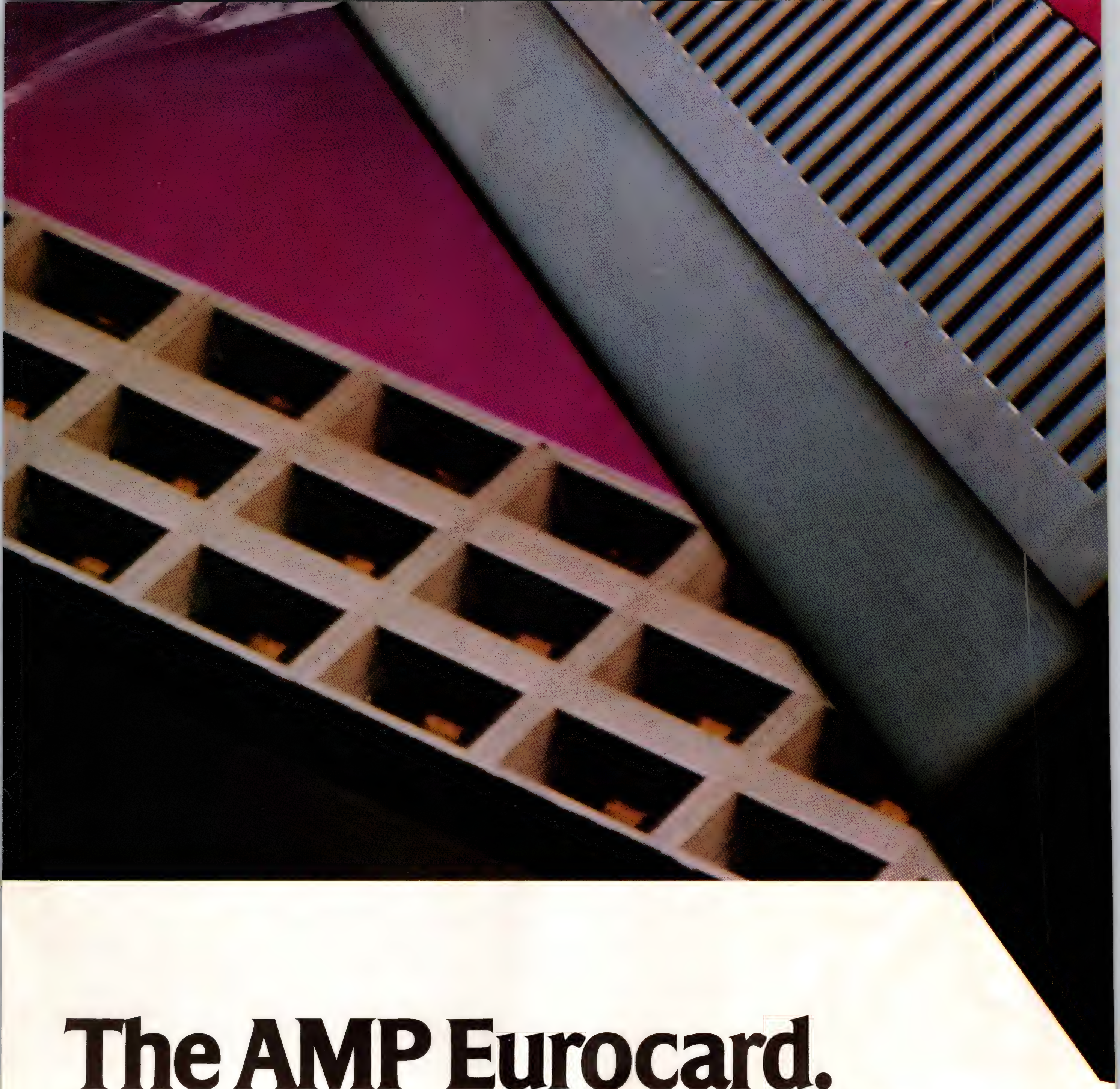
Test the difference and you'll agree that Philips wins on price and performance!

Write to: Philips I & E, T & M department, Building HKF70, 5600 MD Eindhoven, The Netherlands or call your local supplier: **Austria** (222) 629141-0; **Belgium** (2) 5256692/94; **Denmark** (1) 572222; **Finland** (0) 5257225; **France** (1) 48301111; **Germany** (561) 5010; **Great Britain** (0223) 358866; **Ireland** (1) 693355; **Italy** (39) 36351; **Netherlands** (40) 782808; **Norway** (2) 680200; **Portugal** (1) 683121; **Spain** (1) 4042200; **Sweden** (8) 7821800; **Switzerland** (1) 4882211

PHILIPS **Test & Measurement**

PHILIPS

CIRCLE NO 117



The AMP Eurocard.
Now made worldwide.

Don't leave home to get it.

AMP and ACTION PIN are trademarks of AMP Incorporated.

We back our Eurocard commitment with production facilities. So all the benefits you expect from AMP—selection, delivery, specials—are that much closer to home, wherever you are.

In the US, for example, production now covers types C, R, B, and Q, half sizes, and expanded 2 and 3 row specials including our 150-position style.

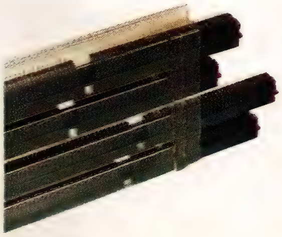
Choose the tail configuration you need, too, including our ACTION-PIN compliant pins. Our latest housing designs allow solderless insertion with simple flat rock tooling.

AMP Eurocard connectors and packaging are also available for automated processes, with high-temp housings, close-tolerance tails. Position data are identical on through-hole and surface-mount housings for easy tooling transition to SMT designs.

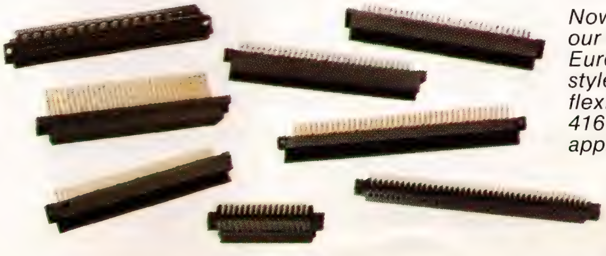
And the support you need to take advantage of all this—from technical expertise to prototypes, to specials, to full systems support—is right in place, right around the corner.

Call (717) 780-4400 and ask for the Eurocard Desk. AMP Incorporated, Harrisburg PA 17105-3608.

AMP Interconnecting ideas



Range of packaging styles with feeder and positioning systems to support robotic insertion. Through-hole Eurocard connectors are designed for tooling compatibility with surface-mount styles.



Now available nearby: our wide variety of AMP Eurocard sizes and styles for packaging flexibility in DIN 41612 and IEC 603-2 applications.

CIRCLE NO 119

HiWIRE™ Starts the Job that smARTWORK® Finishes

Introducing HiWIRE™

Wintek's smARTWORK® is used by thousands of engineers to design printed-circuit boards. Now Wintek introduces HiWIRE, an electronic-schematic program that is easy to learn and use.

With a click of the mouse button, you can extract symbols from our library of over 700 common components and connect them with wires and buses. You can also easily modify the library's symbols or create your own by combining labels, lines, and arcs.

HiWIRE Advantages

- ☐ Easy-to-learn mouse/menu-driven operation
- ☐ Complete documentation and tutorial
- ☐ Extensive TTL, CMOS, microprocessor, and discrete-component libraries
- ☐ Rubberbanding
- ☐ Moving, copying, mirroring, and rotating of symbols
- ☐ Text-string searching
- ☐ Multiple display windows
- ☐ High-quality schematics from printers and plotters
- ☐ Hierarchical-design support; netlist and bill-of-materials utilities
- ☐ Schematic/layout cross checking
- ☐ 800 number for free technical support

System Requirements

- ☐ IBM Personal Computer, PC XT, or PC AT with 320K RAM, parallel printer port, 2 disk drives, and DOS V2.0 or later
- ☐ IBM Color/Graphics Adapter or EGA with RGB color monitor
- ☐ Microsoft Mouse
- ☐ IBM Graphics Printer or Epson FX/MX/RX-series dot-matrix printer, and/or:
- ☐ Houston Instrument DMP-40, 41, 42, 51, 52 or Hewlett-Packard 7470, 7475, 7550, 7580, 7585, 7586 plotter

High Performance at Low Cost

At $895, HiWIRE delivers quality schematics quickly and easily. You don't need to guess whether or not HiWIRE is right for you. Our money-back guarantee lets you try it for 30 days at absolutely no risk. Call (800) 742-6809 toll free today and put HiWIRE to work tomorrow.

Wintek Corporation
1801 South Street
Lafayette, IN 47904-2993
Telephone: (800) 742-6809
or in Indiana (317) 742-8428
Telex: 70-9079 WINTEK CORP UD

WINTEK®

"HiWIRE" is a trademark, and "smARTWORK", "Wintek", and the Wintek logo are registered trademarks of Wintek Corporation.

Europe: RIVA Terminals Ltd., England, Phone: 04862-71001, Telex: 859502/Australia: Entertainment Audio Pty. Ltd., Phone: (08) 363-0454/Brazil: Comicro Informatica E Tecnologia Ltda., Phone: (041) 224-5616

CIRCLE NO 120

Optimize your graphics system for 2-D and 3-D

The design of a graphics system that's both 2-dimensional and 3-dimensional poses some conflicting requirements. You can reconcile some of these conflicts, however, through careful design of the frame-buffer structure, and you can achieve adequate speed for 3-D applications by using parallel processors for computation-intensive tasks.

Anoop S Khurana and Olivier Garbe,
Advanced Micro Devices Inc

A graphics system that will handle both 2- and 3-dimensional applications presents design requirements that are at odds with one another. These conflicts arise from the fundamental differences in the nature of the geometry-, pixel-, and display-processing tasks required by the two systems. A system with a microprogrammed architecture can help you avoid the difficulties you'd encounter in reconciling these differences.

You'd use a 2-D graphics system with such graphics editors as MacDraw, MacPaint, and Interleaf, or with CAE programs such as schematic-capture packages or layout editors for pc-board design. You'd need a 3-D system, on the other hand, to display 3-D wire-frame models, to model solids for mechanical design, or to produce visually pleasing 3-D pictures for animation.

One of the major differences lies in the size of the frame buffer needed, and the speed with which the host computer can obtain access to it. Most 2-D systems need only eight bits to define a pixel color as one of 256 simultaneously displayable colors. A 3-D system, on the other hand, needs eight bits each for red (R), green (G), and blue (B)—a total of 24 bits per pixel. Also, 2-D pixel-processing operations require fast access to multiple pixels during the same frame-buffer cycle. In a 3-D system, by contrast, pixel-processing operations (such as Gouraud shading) are computation-intensive but require access to only one pixel at a time.

Similarly, geometry-processing operations are more arithmetic-intensive in 3-D than in 2-D systems. Fixed-point, 32-bit arithmetic provides adequate computational power and speed for many 2-D applications, whereas 3-D applications need the speed and versatility of fast floating-point arithmetic.

Most of the graphics systems available today, including engineering workstations, are optimized for 2-D graphics operations; if they have 3-D capabilities, they perform the required processing mainly in software, which is slow. To obtain adequate speed, then, serious users of 3-D graphics find that they need a separate system that's optimized for 3-D graphics, resulting in an expensive duplication of hardware and software.

You can avoid these disadvantages by designing a single graphics system that provides all the features

A 2-dimensional graphics system can handle diagrams, but you need 3-dimensional capability for mechanical modeling.

necessary for both 2-D and 3-D graphics. You'll find a microprogrammed architecture ideal for such a system, because such an architecture lets you customize the data paths and computational resources to a particular application and to the performance level that you want. It also lets you integrate both fast integer and fast floating-point arithmetic capabilities, both of which are necessary for complex graphics operations, into a single system.

As an example of such a system, consider the design of a graphics peripheral for a conventional minicomputer. This peripheral can act as a bus master on the host's system bus, but it need not do so. The application program runs on the host computer and generates a display list, defining the image, which the CPU passes to the graphics peripheral via a DMA channel (or by any other appropriate means). The graphics peripheral processes this display list to generate the image. (The steps that convert a display list to an image on the screen are collectively referred to as the "graphics pipeline"; see **box,** "From object to image: the graphics pipeline.") The three main functional blocks of the system are the communications and display-list handler; an update processor that performs geometry and pixel processing; and a display controller **(Fig 1).**

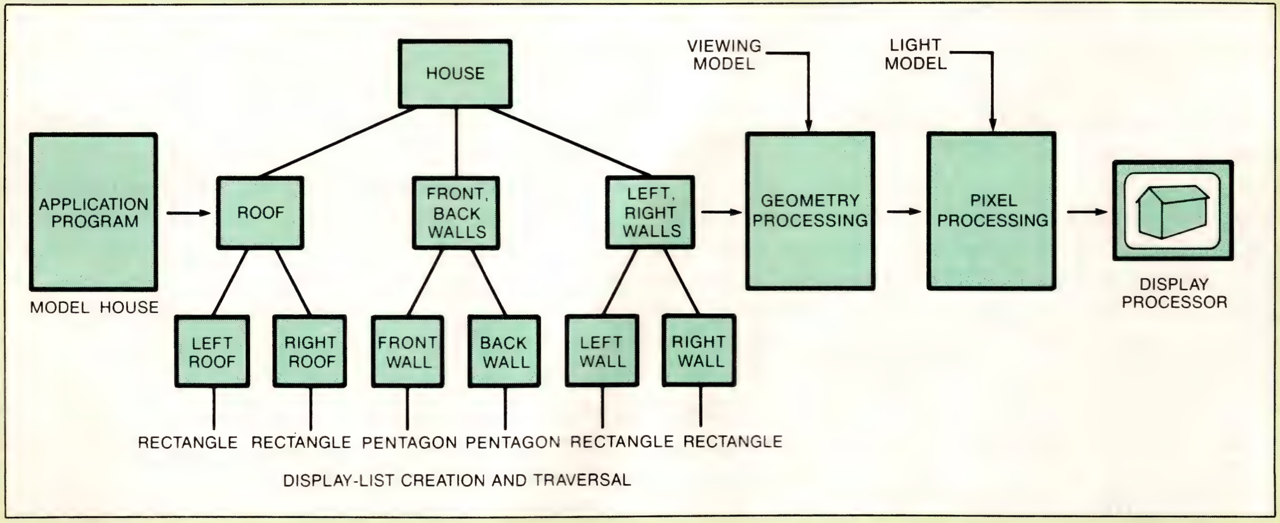
A conventional, general-purpose, 16- or 32-bit μP, which has its own memory and DMA channel, receives and executes commands issued by the host. This communications processor can directly execute some host commands, such as Load Display-List. Other commands, such as Render Display-List, involve the rest of the graphics system; the communications processor analyzes these commands and dispatches appropriate commands to the update processor, using a message-based protocol and a fast, dual-access memory block that serves as a mailbox.

From object to image: the graphics pipeline

The graphics pipeline is the sequence of operations that translates the user's description of a scene into a viewable image. The four stages in this process are display-list handling, geometry processing, pixel processing, and display control.

The display-list handler helps the user or the application program decompose objects to be depicted into a display list. The display list is usually hierarchical, and it embodies the structure inherent in the object being modeled. Leaf nodes in the hierarchy are drawing primitives provided by the graphics system.

The geometry processor performs viewing- and perspective-transformation operations on the display list, and it clips objects against the boundaries of the



The graphics pipeline consists of the processing steps *needed to convert a graphics object description, in digital form, into a viewable image on the screen.*

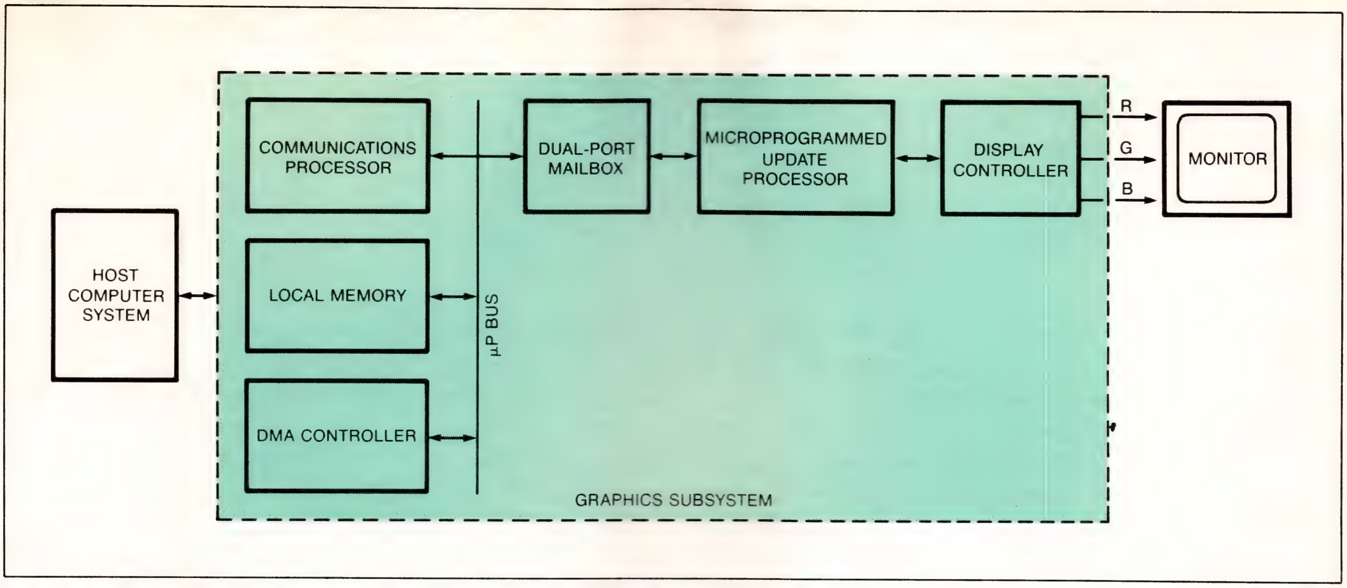


***Fig 1—A graphics subsystem is ideally an intelligent peripheral** that accepts a display list from the host computer and converts the digital representation of an image into a standard video signal that creates a screen display.*

The dual ports of the mailbox allow the update processor to read a command while the communications processor is sending a subsequent command. Semaphores, also located in the mailbox RAM, govern both command chaining and the allocation of memory to message buffers.

The microprogrammed update processor executes all commands that are related to geometry or pixel processing. Such operations may update the pixel data in the frame buffer, or they may pass a message back to the communications processor.

The frame buffer uses video RAM (VRAM) ICs, both to maximize bandwidth and to minimize the quantity of hardware needed for refreshing the image. The frame-

viewing volume. You can decompose the complex primitives used by the geometry processor, such as patches or cubic curves, into simpler primitives, such as polygons or lines.

The pixel processor physically writes all the pixels affected by a primitive into their correct locations in the frame buffer. It also performs all operations, such as pixel-block transfers, that require pixels to be read from or written to the frame buffer.

The display controller converts the pixel values stored in the frame buffer into a standard video signal. This video signal, when transmitted to a suitable monitor, builds the desired image on the screen.

A single, general-purpose processor, such as the Intel 80286, along with the 80287 numeric coprocessor, can perform all the operations in the graphics pipeline sequentially. In such a system, the main processor writes the final value of each pixel to the frame buffer, which forms part of the address space of the main processor. This configuration is relatively slow, however, and the speed may be inadequate for 3-D applications.

You can achieve improved performance by using specialized VLSI peripheral devices, such as the Am95C60 Quad Pixel Dataflow Manager, to speed some of the operations in the graphics pipeline. Most current graphics peripherals relieve the main processor of most of the pixel-processing tasks. Typical functions performed by such peripherals are line drawing, polygon filling, and block transfer of pixels. Because these tasks are relatively standard and are well suited to implementation in high-performance silicon, graphics peripherals yield a substantial improvement in system performance. You can achieve a similar improvement by using high-performance floating-point processors to speed the computation-intensive geometry-processing tasks.

For even higher performance and functionality, you should consider the use of multiprocessing systems that provide one or more processors for each stage in the graphics pipeline. Two factors contribute to the improvement in performance that such systems yield. First, because most graphics operations are vector operations, the concurrent performance of several parts of a task can yield a speed increase that's proportional to the number of processors available. Second, you can fine-tune the system by customizing it for highest performance in just those operations that the applications require.

A microprogrammed architecture lets you customize the resources of the system to the problem you're trying to solve.

buffer controller provides all the signals needed for reading, writing, and refreshing the VRAMs, and for performing all video-refresh functions.

You'll need to organize the structure of the frame buffer carefully to make the most efficient use of the available storage. As noted, for 2-D displays you need only eight bits per pixel, which allows you to display the pixel in one of 256 colors. For 3-D displays, you need at least 24 bits per pixel (eight each for the R, G, and B channels); you may also need, for each pixel, an additional eight bits for the alpha channel and 16 or 32 bits for the Z buffer (a maximum of 64 bits/pixel).

You can reduce the total number of bits per pixel by mapping the Z buffer into a portion of the frame buffer. For example, in a 2k-pixel×1k-line buffer, you could map a 1k×1k-pixel screen into the first 1k pixels of each line and the Z buffer into the second 1k pixels. Consequently, you could access the Z value of a pixel by adding an offset of 1024 to the pixel address. You would need two memory cycles to access both the RGB and the Z values of the pixel. This structure, however, has the great advantage that no bits are irrevocably dedicated to the Z buffer. If you don't need a Z buffer, this memory becomes available for general use.

You'll still have to resolve the discrepancy between the eight bits/pixel needed for 2-D and the 24 bits/pixel needed for 3-D. Your first thought might be to allocate a 32-bit memory word for each pixel, but then you'd be wasting 24 bits in 2-D operations. A better solution is to allow each 32-bit word to be treated as four adjacent 8-bit pixels in 2-D. You could then reorganize a 2k×1k×32-bit memory as a frame buffer of 8k×1k×8 bits. This organization allows you to store one 3-D screen with a resolution of 1024 pixels×1024 lines×32 planes, or several 2-D screens at once.

The frame buffer in our example consists of 64k×4-bit VRAMs and uses the shifter port of each VRAM for video refreshing; the update processor therefore has virtually unlimited access to the frame buffer. It's possible to organize each VRAM as a 256×256×4-bit square area of memory; using this area as a building block, you can create a 2k×1k×4-bit memory array having four rows and eight columns (**Fig 2**). If you want to extend the depth of the array to 32 bits/pixel, you'll need eight VRAMs in each element (called a bank) of the array.

The video display controller (VDC) provides complete control of the frame buffer, both for update operations and for video-refresh operations. In response to a read or write memory-cycle request from the update processor, the VDC generates the appropriate VRAM-control signals ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, etc). If a dynamic-RAM refresh cycle or a transfer cycle for video refresh is already in progress, however, the VDC delays execution of the update cycle until the higher-priority cycle is finished.

Because each access to the frame buffer reads or writes a 32-bit word, the 2k×1k×32-bit frame buffer requires 21 address lines, of which 11 define the X address and the other 10 define the Y address within the array. In the 3-D 32-bit/pixel mode, each 32-bit word in the frame buffer represents one pixel.

In the 2-D 8-bit/pixel mode, each 32-bit word represents four pixels. The 18 most significant address bits select the 8-bit row address, the 8-bit column address, and $\overline{\text{RAS}}$ strobe signals. Decoding the three least significant bits yields a decode signal that selects one of eight adjacent pixels.

The capacitive loading imposed by the VRAMs makes it necessary to buffer the address and control outputs of the display controller. To reduce skew between signals, and thereby achieve a shorter memory-cycle time, you can buffer the address, $\overline{\text{RAS}}$, $\overline{\text{CAS}}$, and XF/G signals within a single IC package, such as the Am2976 11-bit dynamic memory driver used in this example.

Select one of eight pixels

Each of the eight rows in the frame memory receives a separate $\overline{\text{RAS}}$ signal. You can therefore connect to a common 32-bit bus the data ports of all four banks of VRAMs within a column. Each memory cycle now gives access to eight pixels, one from each column. The update processor operates on only 32 bits at a time, however, so you'll need a mechanism to select just one of the eight available words.

You can perform this 8:1 multiplexing quite simply by decoding the three least significant address bits to obtain the $\overline{\text{CAS}}$ signal. As a result, only one bank in memory receives both $\overline{\text{RAS}}$ and $\overline{\text{CAS}}$. Consequently, you can tie together the outputs of all 32 banks in memory, but only the selected bank will drive the bus. To access eight sequential pixels, then, you'd need eight memory cycles.

There's another way to perform the multiplexing, however—one that gives the update processor very rapid random access to any or all of the eight adjacent pixels addressed in a single memory cycle. This method requires eight 32-bit, bidirectional, bus-interface registers. You connect the eight 32-bit words, accessed in parallel from the memory, independently to one port of

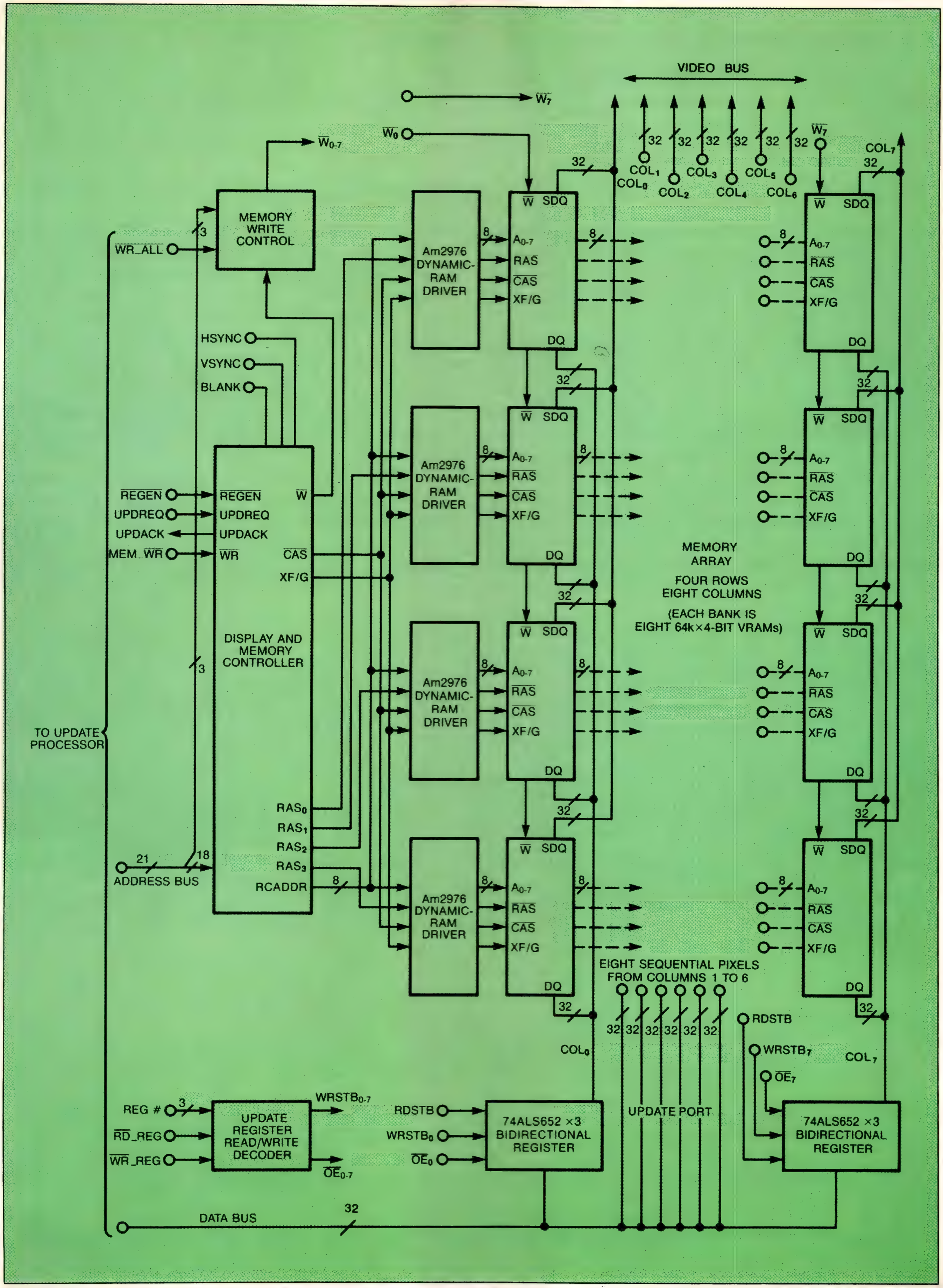


Fig 2—This frame buffer is organized as 2k pixels×1k lines×32 bits. *Three-dimensional applications can read or write eight adjacent pixels at one time. For 2-D applications, each 32-bit word represents four 8-bit pixels.*

A microprogrammed graphics system acts as a peripheral on the host computer's system bus.

these registers. To the other port you tie corresponding bits of each register together to form a single 32-bit bus that leads to the update processor. You then perform the 8:1 multiplexing by controlling the output-enable signals of the registers.

The update processor regards the registers as independent 8-pixel input and output buffers. A memory-read operation fills the input buffer, and the update processor can fetch any or all of the eight pixels much more quickly than if a separate memory cycle were required for each one. You can also provide two different write modes. In the first mode, the update processor writes just one pixel to the appropriate place in memory. In the second mode, the update processor fills all eight registers, and the memory cycle writes their contents to eight different pixels simultaneously.

Refreshing the video display is easy when the display memory consists of VRAMs. At every vertical-sync (Vsync) pulse, the display controller resets an internal video-refresh counter to the address of the upper-left corner of the screen. At every horizontal-sync (Hsync) pulse, the controller initiates a transfer cycle that transfers data for the next scan line into the VRAMs' shift registers and then increments its internal address counter to point to the start of the data for the next line. You can perform panning and scrolling simply by changing the address held in the controller's top-of-frame register.

Given that there are eight memory banks per row, and that each VRAM is capable of shifting at a clock speed of 25 MHz, a total bandwidth of 200M pixels/sec is possible in 3-D mode. In 2-D mode, the available bandwidth becomes 800M pixels/sec. The maximum pixel bandwidth is therefore limited mainly by the

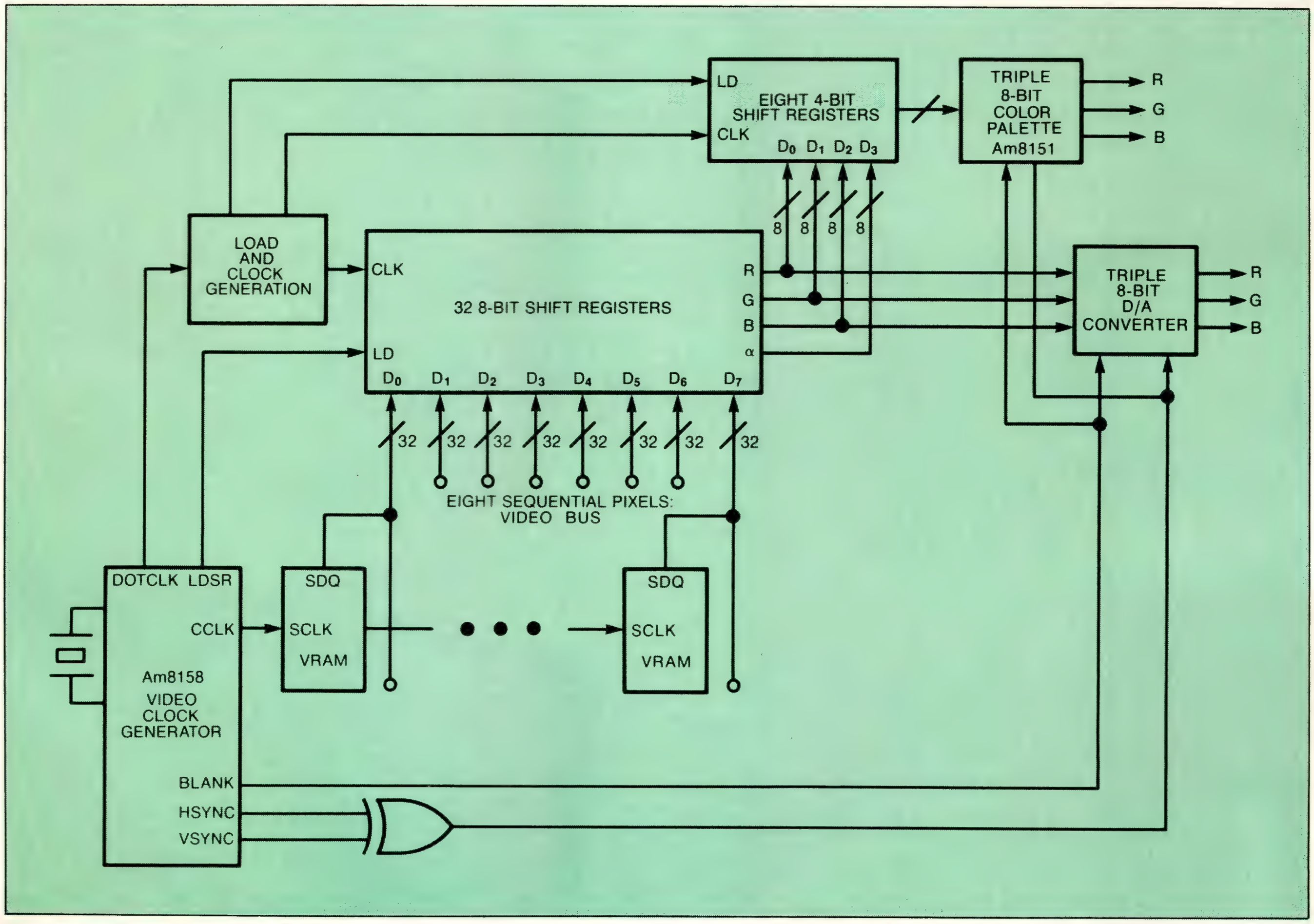

LD
EIGHT 4-BIT SHIFT REGISTERS
CLK
D0 D1 D2 D3
TRIPLE 8-BIT COLOR PALETTE Am8151
R
G
B
8
8
8
8
LOAD AND CLOCK GENERATION
CLK
32 8-BIT SHIFT REGISTERS
R
G
B
α
LD
D0 D1 D2 D3 D4 D5 D6 D7
TRIPLE 8-BIT D/A CONVERTER
R
G
B
32
32
32
32
32
32
32
32
EIGHT SEQUENTIAL PIXELS: VIDEO BUS
DOTCLK LDSR
CCLK
Am8158 VIDEO CLOCK GENERATOR
BLANK
HSYNC
VSYNC
SDQ
SCLK
VRAM
SDQ
SCLK
VRAM

Fig 3—You'll need two video shift registers *if you want to reconfigure the frame buffer from 32-bit, 3-D pixels to 8-bit, 2-D pixels or vice versa. The main register handles eight sequential 32-bit pixels; the secondary register reformats the RGB bit streams from the main register into RGB streams representing 8-bit pixels.*

characteristics of the shift registers and the associated D/A converter, not by those of the memory.

In 32-bit/pixel mode, strobe signals generated by the video clock generator—in this example, an Am8158—load into the video shift registers the eight sequential 32-bit pixels that are in parallel on the video bus (**Fig 3**). The video shift registers consist of 16 dual, 8-bit, parallel-in, serial-out ECL shift-register ICs. These ICs produce serial bit streams of the R, G, and B values of each pixel and forward these bit streams to a triple 8-bit D/A converter.

In 8-bit/pixel mode, the 32 bits that appear at the R, G, and B outputs of the shift registers actually represent four pixels. Four 4-bit ECL shift registers convert the 32-bit data into four 8-bit pixels for use by the Am8151 ECL color palette. To change from one mode to the other, you need only make the appropriate modifications to the Shift and Load signals to the shift registers.

The Am8158 generates the pixel clock pulse and some of the Shift and Load signals used by the shift registers. This IC also generates the Vsync, Hsync, and Blank pulses. The display controller uses these signals to initiate VRAM transfer cycles, and the D/A converters use them to force the video signals to the appropriate sync or blank levels. You can program all the important parameters of these signals using registers contained in the Am8158.

The update processor is microprogrammed

The update processor performs all pixel- and geometry-processing functions for both 2-D and 3-D graphics. These functions require powerful and versatile data-transfer capability coupled with fast integer and floating-point arithmetic. Implementing the update processor as a microprogrammed subsystem allows you to achieve the high performance that you need.

The major functional blocks and buses of the update processor are shown in **Fig 4**. The main data path in this example consists of the Am29332 integer ALU, the Am29323 integer multiplier, and the vector floating-point arithmetic unit, which consists of two Am29325 ICs. Each of these units accepts data from two common 32-bit input buses and places its results on one common 32-bit output bus (the main data bus).

An Am29334 register file provides storage for frequently accessed data. Its read ports supply data to the arithmetic unit's input buses. It also has two write ports, one of which accepts data from the main data bus, while the other transfers the result of an ALU operation back to the register file without using the main data bus. The system timing is such that the ALU can fetch two operands from the register file, process them, and write the result back to the register file within a single microcycle.

The update processor addresses 64k 32-bit words of high-speed local data memory, which consists of static RAM. An Am2131 dual-port message-buffer IC occupies 1k words of the 64k-word address space. To allow the main ALU to process video data at maximum efficiency, an auxiliary Am29C101 16-bit ALU performs all local-memory address computation; the outputs of this ALU are captured in a 16-bit address register. Random accesses to local memory therefore take two microcycles—one to compute and latch the address, and another to access the RAM. During consecutive memory accesses, however, next-word computation overlaps the current RAM access, so that the second and subsequent memory accesses are completed in a single microcycle.

The frame-buffer-address generator consists of presettable up/down counters (an 11-bit counter for the X address and a 10-bit counter for the Y address). The sequencer loads these counters via the main data bus. Although the main ALU is primarily responsible for generating frame-buffer addresses, use of the counters speeds the critical loops in curve drawing and other pixel-processing functions.

The update processor is configured with a single level of pipelining, so that next-address computation overlaps execution of the current microinstruction. The Am29331 sequencer computes the address of the next instruction in response to its instruction inputs, and it places the result on its Y output bus. For access to sequential microcode addresses, this result is simply the contents of the program counter. The sequencer uses an internal stack to store count values for nested loops and return addresses for calls to microcode subroutines.

To execute a jump to an address defined by the microcode, the sequencer connects the address section of the microinstruction word back into its program counter via the A bus. To allow the computation of jump addresses at run time, and to allow external examination of the sequencer's stack and stack pointer, the D bus connects to the main system bus.

An internal condition-code multiplexer, controlled by microcode, selects and enables one of the condition inputs of the sequencer; the sequencer can then test that condition and jump according to the state of the

The organization of the frame buffer is the key to resolving conflicts between 2-D and 3-D requirements.

selected input. For testing as many as four conditions simultaneously, a PAL device accepts all the signals that need to be tested simultaneously and encodes them into four fields of four bits each. A base address is assigned to each field, and the state of the field defines one of 16 sequential locations as an offset from the base address. The sequencer can then examine one of these fields and jump to the location defined by the state of that field. You can use this capability to advantage in a line-clipping algorithm.

In the 2-D mode, one of the most important pixel-processing operations is the movement of a rectangular block of pixels from one area of the frame buffer to another. This process, also known as BitBlt, may also require the execution of a logical operation during the transfer. The update processor transfers data one row at a time from the source block to the destination block. Within a row, the processor may transfer data either left to right or right to left. The sole reason for including the feature that provides fast access to eight pixels in the frame buffer is to speed block transfer. In the 32-bit/pixel mode, the algorithm that transfers one row of the source block to the corresponding row in the destination block has four steps, as illustrated in **Fig 5a** and described as follows:

- Read memory with X=24. This operation transfers pixels 24 through 31 into the frame buffer's read registers. Next, read pixels 31 and 32 into the register file. Then read memory again with X=32. Read five pixels (32 through 36) into the register buffer. You have now transferred the first seven pixels from the source region into the register file (there are only seven valid pixels in the first destination read cycle).
- Read memory with X=96. This operation trans-

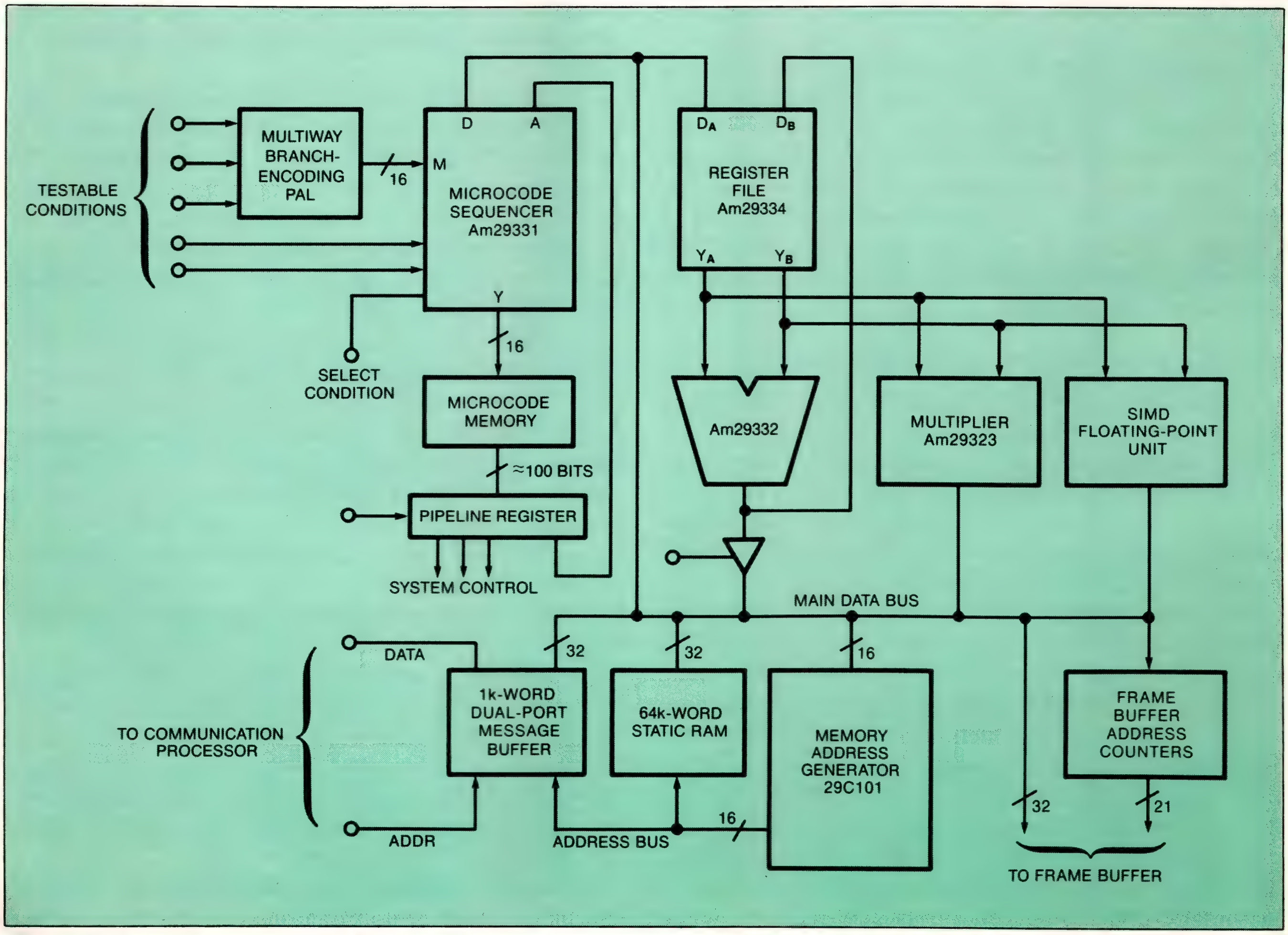


***Fig 4—This update processor,** which handles all geometry- and pixel-processing operations, uses a microprogrammed sequencer for control and parallel floating-point processors for vector operations.*

fers seven valid destination pixels into the frame buffer's registers.

- Read each valid destination pixel, one at a time, and perform any required logical operation with the corresponding source pixel in the register file. Write the resulting pixel back into the frame buffer's write registers. Copy each unread destination pixel from the input register to the output register.
- Write the eight destination pixels in the output registers back to memory. Repeat the sequence until you have transferred the entire row.

Assuming that a memory-read cycle takes 300 nsec and that each frame-buffer read or write operation takes 100 nsec, the total transfer time is 500 nsec/pixel. Using this algorithm, an average covering all possible alignments of source and destination turns out to be approximately 600 nsec/pixel. This time is a substantial improvement over the time of 1200 nsec/pixel for the case in which each memory cycle accesses a single pixel, and it's an acceptable data-transfer speed for 32-bit pixels.

In the 8-bit/pixel mode, the block-transfer algorithm must take into account different alignments of the source and destination within a 32-bit word, and it requires a modification of the procedure. The modified algorithm, illustrated in **Fig 5b,** is as follows:

- Read source words 1 and 2 simultaneously from both output ports of the register file. Using the Am29332 funnel shifter, extract four bytes aligned with the destination, and write this 32-bit word back to a temporary location in the register file. In the example shown, you need to extract the last three pixels of word 1 and pixel S2 from word 2.
- Read this aligned source location, using one register-file port. Read the destination pixel from the frame buffer via the main bus into the second register-file port.
- Perform the logical operation on the aligned-source and destination pixels, using the mask generated internally by the ALU; doing so leaves the first pixel unchanged by the logical operation. Write the result, which appears at the ALU's outputs, back to the frame buffer's input registers at the end of the cycle.

Step 3 of the algorithm now takes three microcycles per word instead of two, and it changes the average transfer time to just over 600 nsec per word. Because each word contains four pixels, the average pixel-transfer time is 600÷4=150 nsec/pixel. This pixel-transfer rate allows an entire 1k×1k-pixel screen to be updated in 150 msec, or about 10 frame times, and is

Text continued on pg 172

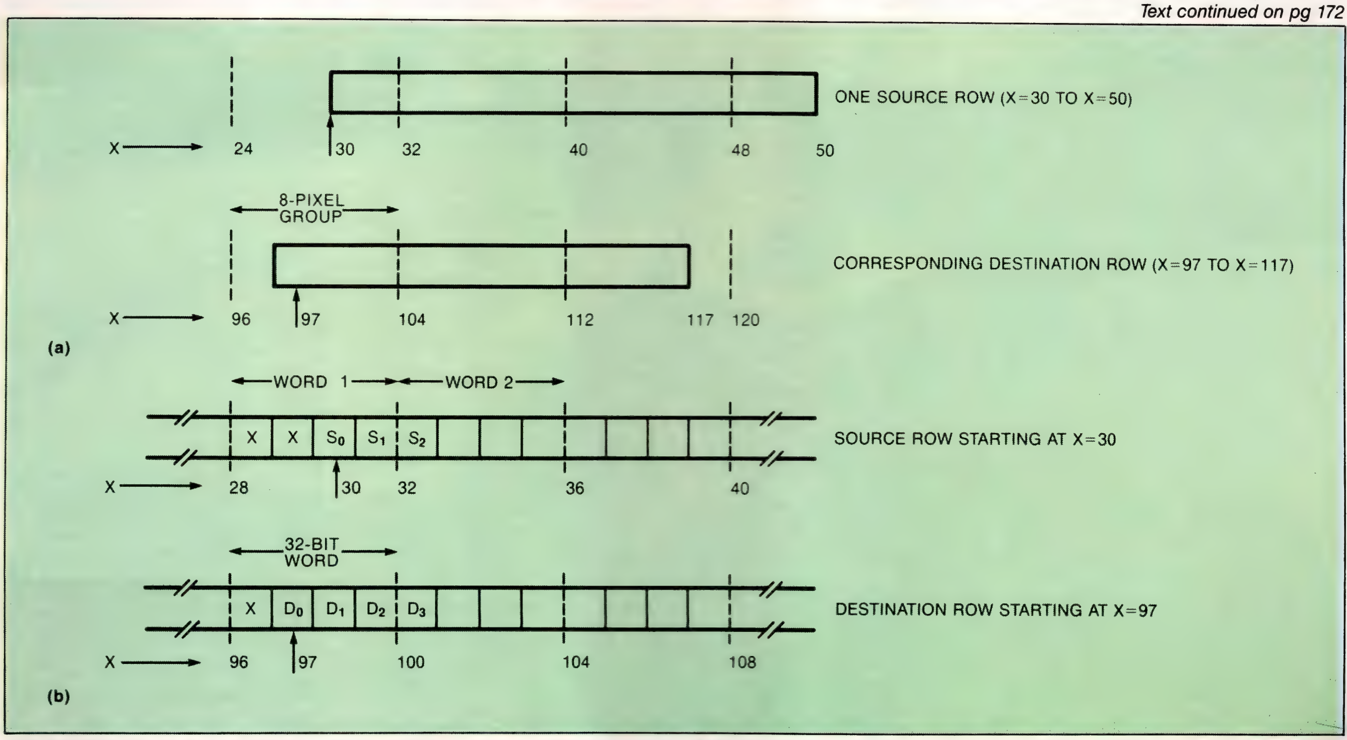


***Fig 5—Pixel block-transfers need careful alignment** of the source and destination within a group of pixels. In 32-bit/pixel mode **(a)**, the group is eight pixels wide. In 8-bit/pixel mode **(b)**, the group is four pixels wide.*

National
Semiconductor

"This isn't going to be easy."

*"The important ones never are.
But that's why we won the bid—
because we can make the
tough decisions."*

*"And because we had the edge
from the very beginning."*

"You mean the Military Series 32000?"

*"Who else offers a true 32-bit
microprocessor supporting Ada
over the full temp range with rad
hardening?"*

*"No one. That's why National
was the easiest part of the decision."*

Military Series 32000. When there's more at stake than the fate of your product.

The Military Series 32000® is the only complete 32-bit military solution.

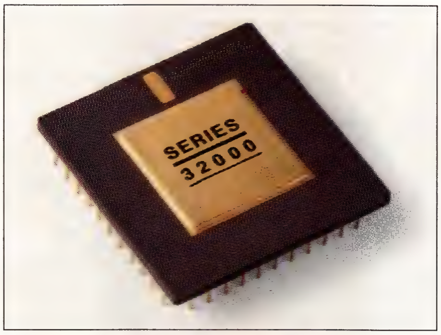
It offers you a rad-hard, JAN, high-performance engine with a full complement of design tools and high-level language support.

Each CPU in the family is 100% compatible with all the other members, so you can migrate your designs to higher performance levels while protecting your software investment.

Each CPU also supports separate floating-point, timing-control, and interrupt-control operations, so you can design exactly the type of advanced system you need.

In today's defense environment, you need the full range of capabilities offered by the Military Series 32000:

Rad-Hard. Sandia National Laboratories selected the Series 32000 over all other 32-bit microprocessors to develop a special CMOS 10^6 radiation-hardened cluster.



Ada.™ The Verdix Ada Development System (VADS™) supports the Series 32000, making it a complete hardware and software package for military applications.

883C. The Series 32000 microprocessor family is designed to comply with MIL-STD-883 Rev. C, including the full temp range of −55°C to +125°C with low-power advanced CMOS fabrication. And, for early prototyping, National has implemented its unique Military Screening Program (MSP), a rigorous new-device testing program that ensures you of fast delivery of high-pedigree devices.

38510. The Series 32000 is also the only 32-bit microprocessor to be selected under a contract from RADC to Boeing Aerospace for characterization of MIL-M-38510 JAN slash sheets.

Which means that *every* 32-bit microprocessor intended for military applications will have to measure up to the Series 32000.

So why trust your design to a microprocessor that has to *meet* the standard—rather than the one that has *set* the standard?

You can't afford to settle for less than the Series 32000. Because the fate of your product—and possibly the fate of a lot more than your product—is resting on your decision.

So make the right one. Contact National Semiconductor today.

National Semiconductor
Series 32000, MS 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

Series 32000 is a registered trademark of
National Semiconductor Corporation.
Ada is a trademark of the U.S. Government
Ada Joint Program Office.
VADS is a trademark of Verdix Corporation.
© National Semiconductor 1986

CIRCLE NO 94

**National
Semiconductor**

The update processor needs fast access to several pixels at a time in the frame buffer.

sufficient for displaying text and manipulating windows.

It's not difficult to implement line- and circle-drawing algorithms, such as those of Bresenham, in microcode. The inner loop of Bresenham's line-drawing algorithm will require three microcycles. Because this time is equal to the time needed to access a pixel in the frame buffer, you can plot pixels at the pixel-access speed of the memory. However, because this algorithm does not profit from the fast access to sequential pixels, the plotting speed will be about the same in both the 32-bit/pixel and the 8-bit/pixel modes. The inner loop of Bresenham's circle-drawing algorithm will require four microcycles, and because each iteration through the loop generates eight points that must be plotted in separate memory cycles, circles too are drawn at the rate of about one pixel in every frame-buffer access time.

Typical pixel- and geometry-processing operations in a 3-D system are computation-intensive and require that you carefully consider the design of the arithmetic unit. Integer arithmetic, although fast, is unsuitable for these graphics operations. Fixed-point arithmetic has disadvantages as well. Although you can readily perform most pixel-processing functions using 32-bit fixed-point arithmetic, fixed-point geometry-processing operations require time-consuming pre- and postscaling operations. For this reason, floating-point operations are easier to develop and are more general in character. Furthermore, there are now many inexpensive floating-point chips, which are almost as fast as integer units and provide all the computation power you need.

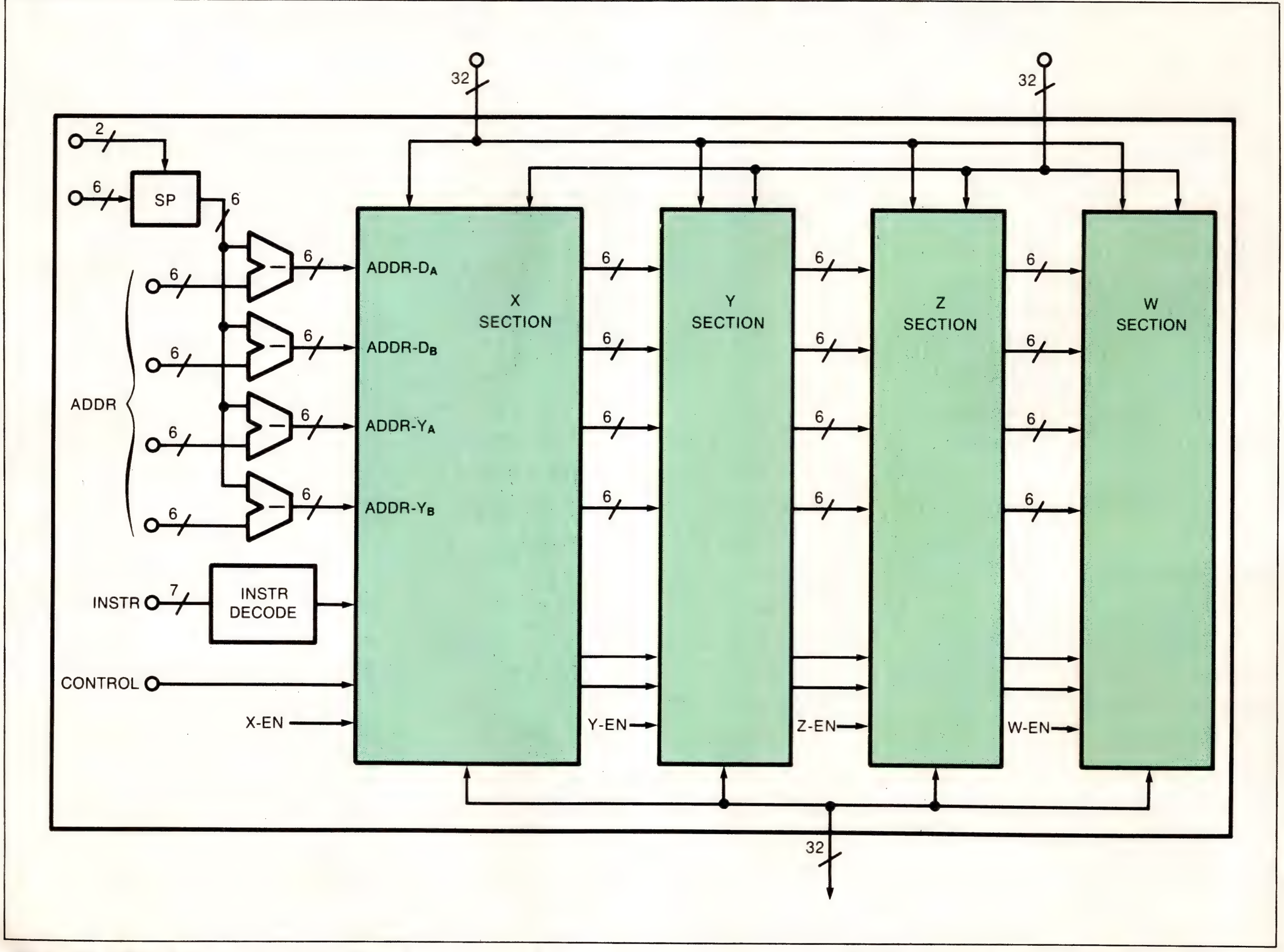


Fig 6—This SIMD floating-point unit has four sections *that share a common control bus. All four sections concurrently perform the same operation on different data.*

TABLE 1—TRANSFORMATION OF A 3-D POINT

CYCLE	EXECUTE	READ/WRITE
1		READ: Y_A=R=ST(0), Y_B=S=ST(4)
2	EXECUTE: F=R * S	READ: Y_A=R=ST(1), Y_B=S=ST(5)
3	EXECUTE: R=R * S	
4	EXECUTE: F=F+R	READ: Y_A=R=ST(2), Y_B=S=ST(6)
5	EXECUTE: R=R * S	
6	EXECUTE: F=F+R	READ: Y_A=R=ST(3), Y_B=S=ST(7)
7	EXECUTE: R=R * S	
8	EXECUTE: F=F+R	
9		WRITE: D_A=F, OUTPUT REGISTER=F (OPTIONAL)

In a graphics system, most of the arithmetic computations are vector operations, because points, plane-equations, transformation matrices, and other common data structures are all vectors. For example, you can represent a point in 3-D space, in homogeneous form, as the vector (x y z w). Although a single processor can perform vector operations sequentially, a multiple-processor system that uses four ICs (in this example, Am29325s) is much faster. If you can distribute the computation tasks among the four processors in such a way that you keep each processor busy all of the time, you can expect to achieve four times the performance of a single processor.

Fortunately, it's quite easy to distribute the simple vector operations that are useful in graphics. For example, perspective division on a point (x y w z) in homogeneous coordinates yields (x/w y/w z/w 1). Consequently, you can perform these divisions in parallel on four different processors, and you can arrange for algorithms that do not map onto such an architecture to run (though more slowly) on a single processor as a sequence of scalar operations. Furthermore, the fact that all processors perform the same operation (division, in this example) at the same time (but on different data) suggests that you should design the floating-point unit as a single-instruction, multiple-data (SIMD) machine, whose processors share a common instruction bus.

You can see the overall structure of a 4-processor SIMD floating-point unit in **Fig 6.** Each section consists of a floating-point processor, a register file, and a seed ROM **(Fig 7).** In each section, a 64-word area of the stack constitutes the register file, and you can address data in the register file with a 6-bit negative displacement from the stack pointer. The microcode word therefore contains four 6-bit fields to specify the addresses of the four ports on the register file. The stack-addressing capability allows microcode subroutines to be completely general in character, and if you first load the stack pointer with zero, you can use the microcode-word displacement fields to specify absolute addresses.

The seven instruction bits of the main microcode word, when decoded, provide all the output-enable and multiplexer-select signals needed to reflect all possible arithmetic-operation and source/destination combinations. Twenty-four bits specify the addresses for the four ports of the register file, two bits control write operations on the D_A and D_B ports of the register file, and one bit switches the source-select multiplexer located at the register file's D_A input. Two additional bits determine whether the stack pointer is to be left unchanged, incremented, decremented, or loaded from the data bus.

A data-access microcycle consists of three time slots. In the first slot, the address hardware computes register-file addresses by adding the displacement specified in the microcode word to the current contents of the stack pointer. In the second slot, data is written into the register file. In the last slot, data required for the next execution cycle is read from the register file.

The pipelined structure of the floating-point unit allows the overlapping of arithmetic operations with operations that access data from the register file. As a rule, the floating-point unit must access data from the register file one microcycle before using that data in an arithmetic operation. In many cases, however, the data needed for the next operation is already held in the Am29325's internal registers, so that a register-access cycle is unnecessary. Furthermore, most graphics operations allow execution cycles to overlap data-access cycles in a similar manner. Consequently, the effective throughput of the floating-point unit remains close to one operation per microcycle.

Guidelines for coding typical operations

As an example of how you can distribute portions of an operation among the four processors, consider the transformation of a 3-D point in homogeneous coordinates, using a ×4 matrix. The first step is to broadcast all four coordinates of the point to be transformed, and to write them into the register files of all four sections of the floating-point unit simultaneously. Because the register file also acts as the matrix stack, the transformation matrix is already established in the floating-point unit. You then distribute the transformation matrix among the four sections, storing only one column of the matrix in each section.

Assume that the point to be transformed is on top of the stack at [ST(0) ST(1) ST(2) ST(3)], and that the matrix column is at [ST(4) ST(5) ST(6) ST(7)], where ST(n) refers to the data n words down from the current stack pointer. You perform the transformation by computing the dot product of the point and a column of the transformation matrix. You can now compute, in parallel, the four dot products needed to transform each

Text continued on pg 176

National
Semiconductor

When George Tobias and his design team needed every ASIC solution–from PLDs to gate arrays to standard cells–they called every ASIC company they needed: National.

It's the pressure every design engineer is familiar with. The pressure to squeeze more functionality into a smaller space.

That's why today's designs are requiring more ASIC solutions — and more than one type of ASIC solution in the same system.

And that's why more designers, like George Tobias and his team, are calling the one company that can meet all their needs in every ASIC category and can provide the full range of design tools, technical support, manufacturing capacity, and long-term commitment to ensure that those needs will be met on time, on budget, and in spec.

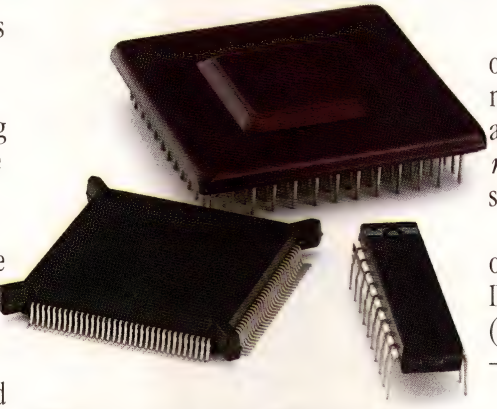
That one company is National Semiconductor.

NO ONE OFFERS YOU MORE DESIGN FLEXIBILITY

National is the only company in the industry that can offer you a clear-cut upward-integration path from programmable logic devices to gate arrays to standard cells.

And we're the only company that can offer you a full range of capabilities *within* each of those categories.

Programmable logic. National has one of the most complete PLD listings available. We offer a variety of circuit types in a variety of process technologies, including bipolar, CMOS, and ECL.



Gate arrays. National has one of the most complete gate-array listings available. We offer a variety of densities, from 600 to 8700 equivalent gates, with higher densities in development, all with sub-nanosecond speeds.

Standard cells. National has one of the most complete standard-cell listings available. We offer a variety of functional blocks in a comprehensive and continually expanding cell library that will include logic, linear, memory, interface, microprocessor, and peripheral elements.

And you're not "stuck" at any level. Once you're comfortable with your programmable-logic design, for example, you can integrate the PLDs and glue logic into a gate array.

Or you can prototype your design as a gate array and then migrate it directly — with no re-engineering — to the full integration of a standard cell.

Or you can simply stay with your gate-array solution indefinitely, knowing that you can "tweak" your design relatively easily to maintain your competitive edge.

NO ONE OFFERS YOU MORE DESIGN SUPPORT

National is the only company in the industry that has committed the full magnitude of its semiconductor technology to the development of a complete cell library.

With a standard-product list that includes over 9,000 proven devices, we not only have more circuit-design experience, but we also have a broader base of circuit-design *resources* to help you implement your specific application.

And you can tap into those resources on all the leading workstations, including Daisy, Mentor, Valid, and Futurenet (IBM® PC).

NO ONE OFFERS YOU MORE MANUFACTURING CAPACITY

National is the only company in the industry that can offer you a complete, comprehensive, dedicated ASIC manufacturing capability.

In Santa Clara, California, we have a dedicated 4-inch quick-turn line that can give you rapid prototyping and small production runs.

And in Arlington, Texas, we have a world-class, 6-inch wafer-fab operation that meets Class-10 standards to give you high volume with high reliability.

So whether you're an experienced ASIC designer or you're just now ready to take that first big step toward higher integration, whether you're working with a single design or dozens, whether you need one device or millions, there's only one company that is as committed to your ASIC needs as you are.

National.

National Semiconductor
ASIC Solutions
P.O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor

IBM is a registered trademark of International Business Machines Corporation.

© 1987 National Semiconductor

CIRCLE NO 95

The update processor is configured with a single level of pipelining, so that next-address computation overlaps execution of the current microinstruction.

component of the vector, one in each section of the floating-point unit. The entire transformation can complete within nine microcycles **(Table 1).**

You can use the same approach to perform matrix-matrix multiplication. In this case, assume that the current transformation is on top of the stack, with one column in each section. You can now treat a row of the new matrix as a point and transform it by the matrix held on top of the stack to yield a row of the transformed matrix. You repeat this procedure four times (once for each row) to obtain the complete result. A matrix-matrix multiplication therefore takes 36 microcycles.

You can also perform parallel interpolation, using forward differences, when drawing cubic curves such as splines and Bezier curves. In this case, each iteration requires three addition operations, and because each component of the vector requires an identical computa-

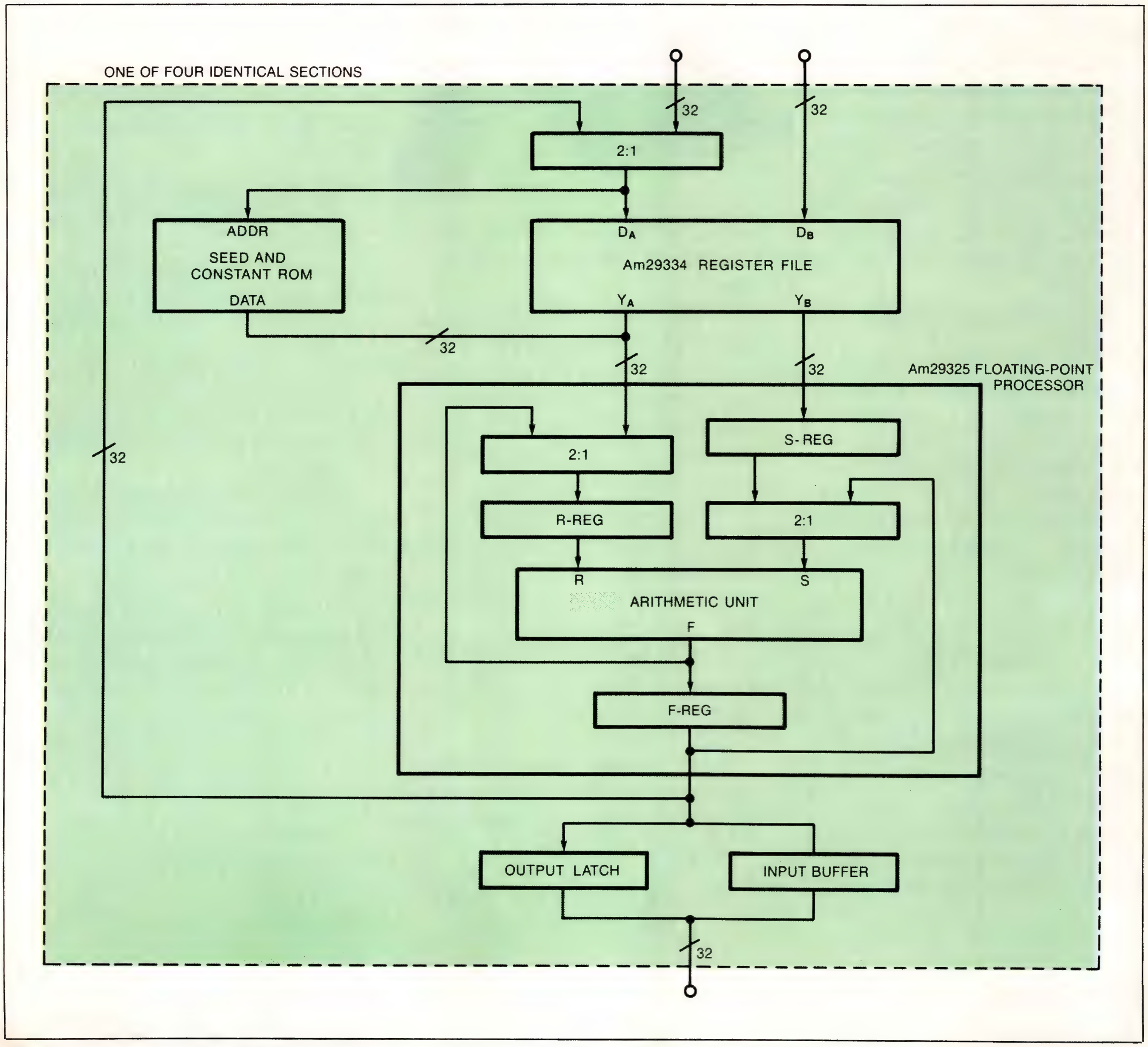


Fig 7—Each section of the SIMD floating-point unit is identical *with the others, and each has its own register file, seed and constant table, and floating-point processor.*

tion, you can perform the four computations in parallel in the four sections. Consequently, you can compute a new point every four microcycles. In the computation shown below, D_X, D_{2X}, and D_{3X} are the first-, second-, and third-order forward differences for the X coordinate:

$$[X\ D_X\ D_{2X}\ D_{3X}]=[X\ D_X\ D_{2X}\ D_{3X}]+[D_X\ D_{2X}\ D_{3X}\ 0]$$

$$[Y\ D_Y\ D_{2Y}\ D_{3Y}]=[Y\ D_Y\ D_{2Y}\ D_{3Y}]+[D_Y\ D_{2Y}\ D_{3Y}\ 0]$$

$$[X\ D_Z\ D_{2Z}\ D_{3Z}]=[Z\ D_Z\ D_{2Z}\ D_{3Z}]+[D_Z\ D_{2Z}\ D_{3Z}\ 0]$$

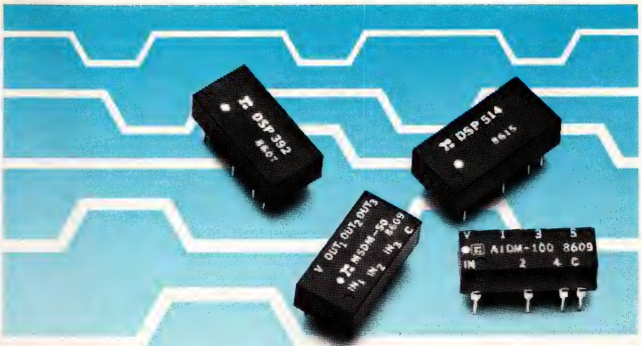
Perspective division requires a division operation, and the normalization of an interpolated vector, in the inner loop of Phong shading, requires square-root operations. The Am29325 does not perform division and square roots directly, however. Instead, it uses Newton-Raphson iteration to obtain the corresponding results. The seed ROM provides the seed (or first approximation) to start the iteration procedure. Each iteration requires three microcycles for division and five microcycles for square roots. Refining the seed to approximately single-precision accuracy requires another three microcycles. Consequently, each division operation requires a total of ten microcycles, and each square-root operation requires sixteen microcycles. Furthermore, because each processor in the floating-point unit has its own seed table, four such computations can proceed in parallel. **EDN**

Author's biography

Anoop S Khurana is a product planning engineer for advanced graphics at Advanced Micro Devices (Sunnyvale, CA). He's responsible for specifying architectures for peripheral graphics controllers. He holds a BSEE from the University of Roorkee in India and an MSEE from the University of Florida (Gainesville). His hobbies include squash, reading, and hiking.

Olivier Garbe is department manager for graphics and office automation in AMD's product-planning group. He is responsible for new-product definition. Olivier has a Diplome d'Ingénieur from L'Ecole des Travaux Publics in Paris. His hobbies are PC hardware, wind surfing, water skiing, and scuba diving.

Article Interest Quotient (Circle One)
High 476 Medium 477 Low 478



PERFECT TIMING!

Rhombus has created some brand new TTL delay modules — just when you needed solutions to your circuit-timing problems.

Now, Rhombus high quality TTL delay modules are also available in auto-insertable, 8 pin auto-insertable mini-dip, and surface mount packages. Designed to speed installation and save space, these new delay modules meet the same high-performance levels of all Rhombus delay lines, and meet or exceed all applicable environmental requirements of MIL-D-23859, MIL-STD-883 and MIL-STD-202.

Of course, the complete line of Rhombus passive, ECL and TTL buffered delay lines is also available to meet your circuit-timing needs.

Looking for unencumbered design freedom? Now's the perfect time to call Rhombus for your closest Rhombus representative or distributor.

RHOMBUS INDUSTRIES INC.
15801 Chemical Lane, Huntington Beach, CA 92649
(714) 898-0960 • (213) 594-8918
TWX: 910-596-1826 • FAX: (714) 896-0971
TELEX: 62891137 RHOMBUS HTBH

CIRCLE NO 26

FAIL-SAFE PROTECTION

DESIGN NO. 2

FOR: CMOS MEMORY BACK-UP
STAND BY POWER
PRIMARY POWER SOURCE

HORIZONTAL CELL SERIES

STANDARD PC VERSION
TAB VERSION
BH-C STANDARD PC VERSION WITH TAPERED BEAM FITTINGS FOR LARGER CELLS

- **Fit standard 3V lithium cylinder cells. Sizes 1/3N, 2N, 2/3AA, 2/3A, 1/2AA, AA, C, 9-Volt**
- **Wave solder PC board mounting and hard wire available**
- **Excellent electrical conductivity. Nickel plated stainless steel contacts.**

MPD's horizontal cell holders are made from high temperature resistant UL94V-O VALOX® material. Unique design assures proper polarity of easily inserted batteries. Also accepts, NiCd, Carbon-Zinc and Alkaline cells.

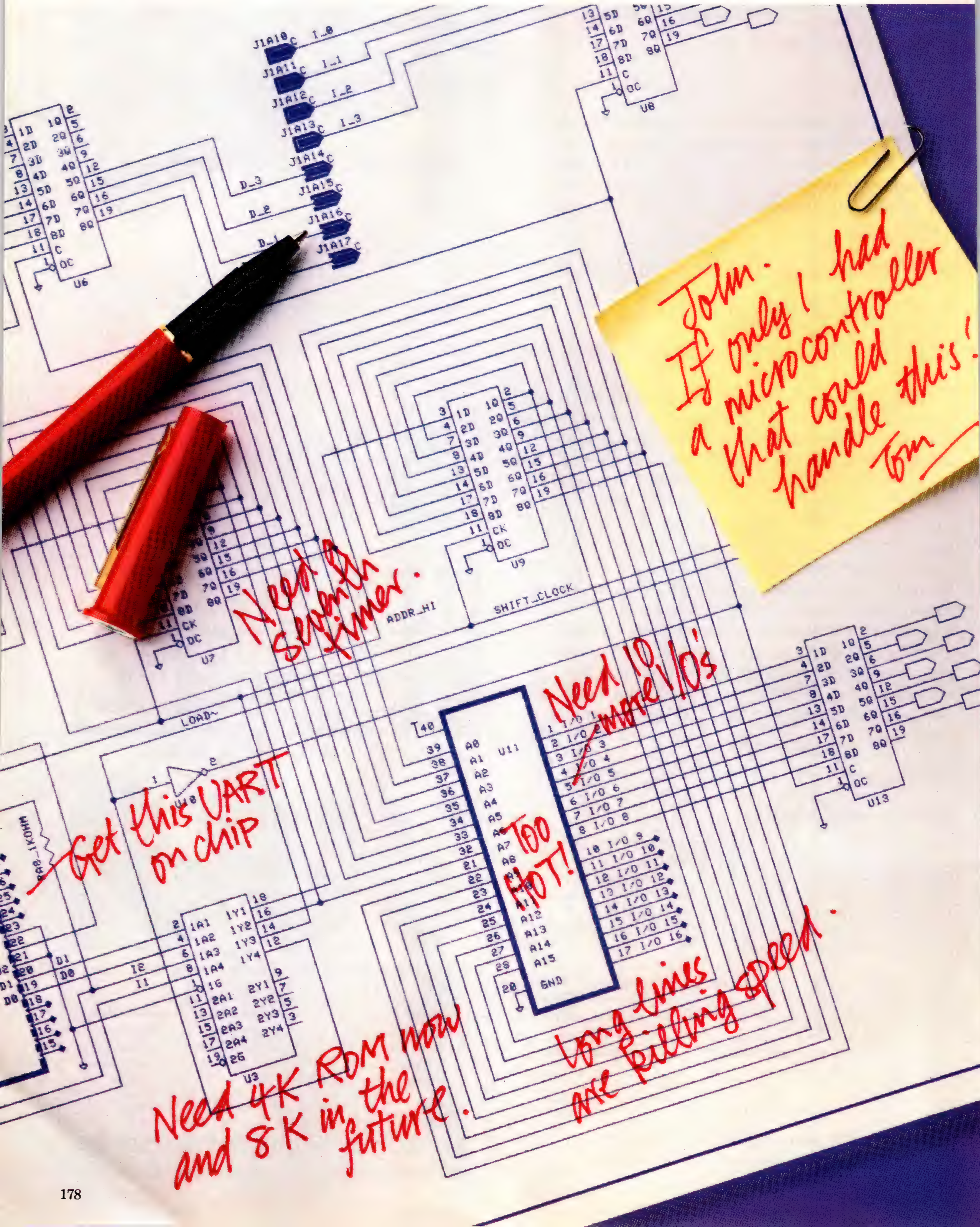
VALOX® is a Registered Trademark of General Electric Company

Custom battery holders on request. Call or write today for more details.

Memory Protection Devices Inc.
36 South Mall, Plainview, NY 11803 • 516-454-0340 • Telex 7105815590

CIRCLE NO 27

National Semiconductor



Introducing the no-compromise microcontroller.

NATIONAL'S 17 MHz HPC,™ THE WORLD'S FASTEST MICROCONTROLLER, LETS YOU DESIGN THE WAY YOU WANT TO… NOT THE WAY YOU HAVE TO

Think of those designs that could have led to higher sales, if only your microcontroller had been faster… had used less power… or had come with a family of on-board functions to fit your application.

Remember the performance compromises you made because that microcontroller didn't exist.

It does now… for a lot less than you would expect to pay for such performance.

THE FASTEST EXECUTION TIME YET

At a clock rate of 17 MHz, HPC offers a 240-nanosecond instruction cycle, the fastest on the market. It also has a powerful instruction set, with 16x16-bit multiply and 32x16-bit divide. Which means you'll get the high throughput necessary for today's compute-intensive controller applications.

THE HIGHEST LEVEL OF INTEGRATION

Your system will need fewer components, operate at higher speeds and be more reliable with on-board functions, such as: software programmable UART; high-speed input/outputs (52 general-purpose I/O lines/68-pin package); 16-bit timers, including six PWMs and a watchdog timer; input capture registers; ROM and RAM; and MICROWIRE/Plus,™ a three-wire, synchronous interface, connecting HPC to proprietary and standard peripherals.

The first 16-bit CMOS High Performance microController family is available now.

AN EXPANDING PRODUCT LINE

HPC's modular common-processor core and memory-mapped architecture gives us the flexibility to introduce many new parts in the family. Choose from memory and on-board peripherals, and, soon EEPROM, A/D, HDLC protocol controllers, DMAs and gate arrays to create a powerful microcontroller for your automotive, telecom, data processing, military, medical, factory automation or industrial control application.

THE BENEFITS OF ADVANCED CMOS

HPC employs National's double-metal advanced CMOS process technology. The device uses very little operating power and is designed for low power consumption in HALT and IDLE modes. In addition, it operates over a wide range of supply voltages, from 3 to 5.5V, and temperatures from −55° to +125°C.

LOW-COST, COMPREHENSIVE SUPPORT

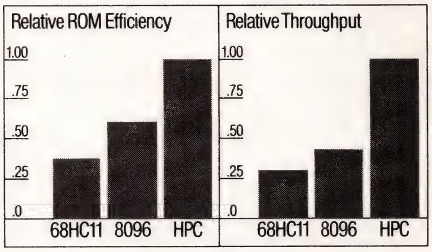
Our Microcontroller On-Line Emulator (MOLE™) provides low-cost support from initial software development to final hardware emulation and ROM pattern submission. It works with any IBM PC or compatible and has high-level language support, including a C compiler.

Plus, you'll get fast, expert help when you need it through "Dial-A-Helper," our exclusive on-line application assistance program. Available 24 hours a day. Free of charge.

BACKED BY AN ON-GOING COMMITMENT

We've developed the broadest family of 4-, 8- and 16-bit microcontrollers of any U.S. based manufacturer. That commitment continues as we expand the family at our world-class six-inch wafer fabrication facility dedicated to advanced CMOS process technology. Today, at 2 microns, 17 MHz. Tomorrow: 1.5 microns, 20 MHz and above.

COMPARE THE HPC TO THE COMPETITION



DON'T SETTLE FOR A COMPROMISE

We have HPCs available now: HPC16030, HPC16040, HPC16073 and HPC16083. Available in various mil-temp ranges and package options, including PLCCs. For more information, contact us today.

National Semiconductor
MS 23-205
P. O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor

HPC, MICROWIRE/Plus and MOLE are trademarks of National Semiconductor Corp.

CIRCLE NO 96

National Semiconductor

Advanced Peripherals

There just isn't a discrete way to do this.

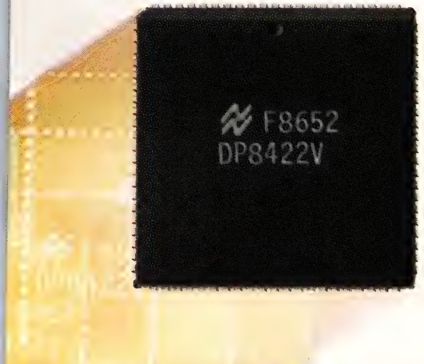
INTRODUCING THE WORLD'S FIRST FULLY INTEGRATED 4 MBIT DRAM CONTROLLER. AND THE FIRST AFFORDABLE LSI SOLUTION

It's easy to improve your memory array controllers. But you don't have to be discrete to do it. Because now National has the LSI solution:

The world's first fully integrated 4 Mbit, low-power advanced CMOS DRAM controller/driver. Our new DP8422.

It can directly drive up to 64 megabytes. Fast. Because it operates without waitstates. And it's flexible enough to interface to National's Series 32000® or any 8-bit, 16-bit or 32-bit microprocessor or system bus. Without external circuitry.

So you'll save both design time and valuable real estate. And we made it completely programmable, so it can be tailored to your specific applications.



But best of all, this incredible performance comes in at the best value around. No other LSI or discrete solution can even come close.

ONLY NATIONAL PROVIDES SUCH AN ADVANCED DEVICE

DP8422 DRAM CONTROLLER

- Directly addresses and drives up to 64 megabytes using 4 Mbit DRAMs
- Eliminates CPU waitstates
- Fully programmable
- High capacitive drivers
- Interfaces to any 8-bit, 16-bit or 32-bit microprocessor or system bus
- Low-power, 2-micron microCMOS process
- Supports all major DRAM types and access schemes, including video RAMs
- Dual-CPU-access supported
- High-precision delay line
- Support for error detection and correction
- Low-cost, high-density PLCC packages
- Meets Military/Aerospace specifications

WHEN PERFORMANCE COUNTS, YOU'VE GOT CONTROL

All major DRAM types and access schemes are easily supported.

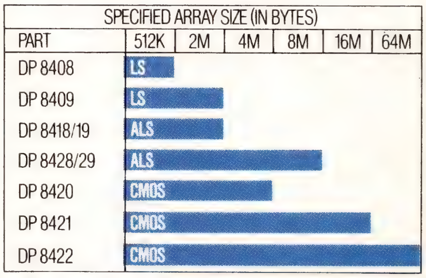
If you have a second CPU, DMA, LAN or graphics controller that requires shared access to the same memory array, it's no problem. The DP8422 provides on-board arbitration logic to support shared memory accessing.

For your applications using a single CPU, there are the DP8421 1Mbit and DP8420 256K DRAM controllers.

Each is perfect when high-performance memory access is essential. You can be sure of that, with speed features such as support for Burst/Nibble, Page and Static Column memory-access modes, as well as memory interleaving.

These integrated DRAM controllers can actually match the advanced bipolar performance levels achieved by the industry's fastest DRAM controllers — National's DP8418/19 and DP8428/29s.

CHOOSE FROM NATIONAL'S BROAD RANGE OF DRAM CONTROLLERS



Programmable video RAM controller/drivers are also available as a part of National's Advanced Graphics Chip Set (DP8520/21/22).

DISCRIMINATING DESIGNERS DON'T NEED TO BE DISCRETE

When you look for LSI memory support, National has always been the one with the right solution. And now we've broken through the discrete price/performance barrier to make LSI the best solution. In terms of performance, flexibility and cost.

So no matter what choices you've looked to in the past, take advantage of National's full range of DRAM controllers.

For more information, call your National sales engineer or distributor today.

Memory Support
National Semiconductor
M/S 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

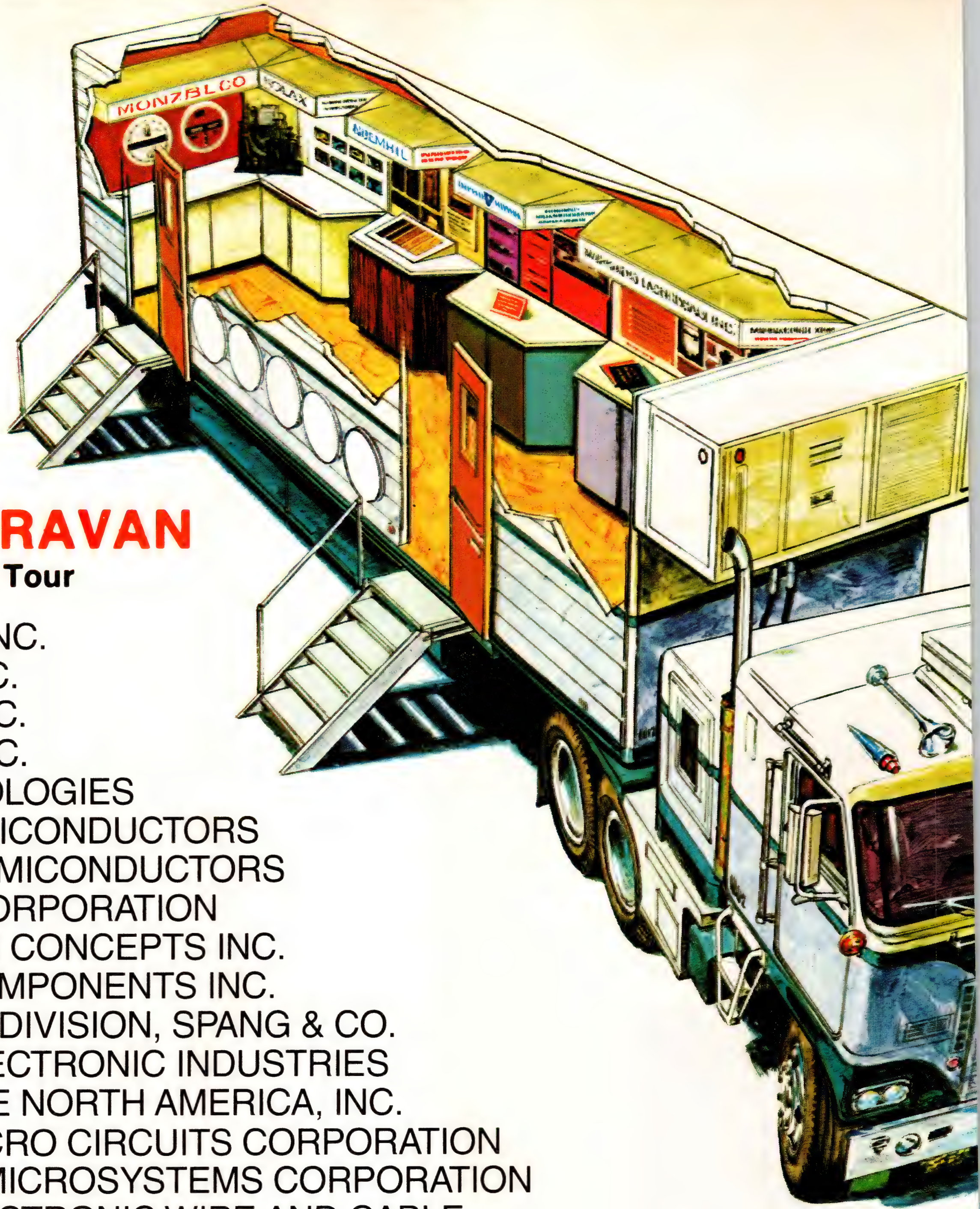
National Semiconductor

Series 32000 is a registered trademark of National Semiconductor Corporation.

© 1987 National Semiconductor Corporation.

CIRCLE NO 97

See the all new 1987



EDN CARAVAN

Western Show Tour

POWEREX, INC.
BOURNS, INC.
SOURIAU, INC.
GRAYHILL INC.
SFE TECHNOLOGIES
HARRIS SEMICONDUCTORS
PLESSEY SEMICONDUCTORS
LSI LOGIC CORPORATION
CONVERTER CONCEPTS INC.
STANTEL COMPONENTS INC.
MAGNETICS DIVISION, SPANG & CO.
TADIRAN ELECTRONIC INDUSTRIES
MURATA ERIE NORTH AMERICA, INC.
APPLIED MICRO CIRCUITS CORPORATION
STANDARD MICROSYSTEMS CORPORATION
BELDEN ELECTRONIC WIRE AND CABLE
GOULD INC., SEMICONDUCTOR DIVISION
CLIFTON PRECISION DIV., LITTON SYSTEMS, INC.
REXNORD SPECIALTY FASTENER DIVISION.

CHECK THE ITINERARY FOR THE DATE WE VISIT YOU!

1987 WESTERN EDN CARAVAN TRAVELING ELECTRONIC SHOW
March 23 to May 1 (last half)

DATE	TIME	SITE
23 onday	9-11:30 AM	SPERRY FLIGHT SYSTEMS 2111 N. 19th Ave., Phoenix, AZ
23 onday	1:30-3:30 PM	SIEMENS TRANSMISSION SYSTEMS 2500 W. Utopia Rd., Phoenix, AZ
24 uesday	9-12 AM	MOTOROLA GOVERNMENT ELECTRONICS 8201 E. McDowell Rd., Scottsdale, AZ
24 uesday	1-2:30 PM	MOTOROLA RADAR SYSTEMS 2100 E. Elliot Rd., Tempe, AZ
24 uesday	3-4:30 PM	MOTOROLA STRATEGIC ELECTRONICS 2501 S. Price Rd., Chandler, AZ
/25 Wednesday	9-11 AM	IBM CORPORATION Rita Rd., Tucson, AZ
/25 Wednesday	12:30-3:30 PM	HUGHES AEROSPACE COMPANY Negales Hwy., Tucson, AZ
/27 riday	9-12 AM	SANDIA NATIONAL LABS Kirtland AFB, Albuquerque, NM
/27 riday	1:30-4 PM	SPERRY AEROSPACE AND MARINE GROUP 9201 San Mateo Blvd. NE, Albuquerque, NM
/30 Monday	9-11 AM	HEWLETT-PACKARD COMPANY 3404 E. Harmony Rd., FT. Collins, CO
/30 Monday	1:30-3 PM	HEWLETT-PACKARD COMPANY 700 71st Ave., Greeley, CO
/31 Tuesday	9-11 AM	HEWLETT-PACKARD COMPANY 815 14th SW, Loveland, CO
/31 Tuesday	1-3 PM	BALL AEROSPACE SYSTEMS Boulder Industrial Park, Boulder, CO
/1 Wednesday	9-11 AM	IBM CORPORATION 6300 Diagonal Hwy., Boulder, CO
/1 Wednesday	1-3 PM	AT&T INFORMATION SYSTEMS LABS 11900 N. Pecos St., Denver, CO
/2 Thursday	9-10:30 AM	MARTIN MARIETTA CORPORATION Hwy 470, Waterton, CO
4/3 Friday	9-11 AM	DIGITAL EQUIPMENT CORPORATION 301 Rockrimmon Blvd., Colorado Springs, CO
4/3 Friday	1-3 PM	HEWLETT-PACKARD COMPANY 1900 Garden of Gods, Colorado Springs, CO
4/6 Monday	8:30-11:30 AM	GENERAL DYNAMICS CORPORATION Grants Lane, Ft. Worth, TX
4/6 Monday	2-4 PM	E-SYSTEMS INCORPORATED 1200 Jupiter Rd., Garland, TX
4/7 Tuesday	8:30-10 AM	TEXAS INSTRUMENTS INCORPORATED Forest Lane, Dallas, TX
4/7 Tuesday	10:30-12 AM	TEXAS INSTRUMENTS INCORPORATED 13500 N. Central Exwy., Dallas, TX
4/7 Tuesday	2-4 PM	LTV AEROSPACE AND DEFENSE 1902 W. Freeway, Dallas, TX
4/8 Wednesday	8-9:30 AM	TEXAS INSTRUMENTS INCORPORATED 2501 S. Hwy. 121, Lewisville, TX
4/8 Wednesday	10:45-12 AM	TEXAS INSTRUMENTS INCORPORATED Central Expwy., McKinney, TX
4/8 Wednesday	2-4 PM	E-SYSTEMS INCORPORATED Farm Rd. 1570, Greenville, TX
4/9 Thursday	8:30-10 AM	ROCKWELL INTERNATIONAL CORPORATION 1200 N. Alma Rd., Richardson, TX
4/9 Thursday	10:45-12 AM	ROCKWELL INTERNATIONAL CORPORATION Shiloh Rd., Richardson, TX
4/10 Friday	9-12 AM	IBM CORPORATION 11400 Burnet Rd., Austin, TX
4/10 Friday	1-3 PM	TRACOR INCORPORATED 6500 Tracor Lane, Austin, TX
4/13 Monday	9-11:30 AM	BOEING MILITARY AIRPLANE COMPANY 3801 S. Oliver, Wichita, KS

DATE	TIME	SITE
4/13 Monday	1:30-3 PM	NCR CORPORATION 3718 N. Rock Rd., Wichita, KS
4/14 Tuesday	9-11 AM	KING RADIO CORPORATION 400 N. Rogers Rd., Olathe, KS
4/15 Wednesday	9-11:30 AM	ROCKWELL INTERNATIONAL CORPORATION 400 Collins Rd. NE, Cedar Rapids, IA
4/15 Wednesday	1-3 PM	ROCKWELL INTERNATIONAL CORPORATION 855 35th St. NE, Cedar Rapids, IA
4/16 Thursday	9-11:30 AM	IBM CORPORATION Hwy. 52 and NW 37th St., Rochester, MN
4/16 Thursday	2-3:30 PM	E. F. JOHNSON COMPANY 299 Johnson Ave. SW, Waseca, MN
4/17 Friday	9-11 AM	CONTROL DATA CORPORATION 3101 E. 80th St., Minneapolis, MN
4/20 Monday	8:30-10 AM	HONEYWELL DEFENSE SYSTEMS Country Rd. 18, Edina, MN
4/20 Monday	10:45-12 AM	MAGNETIC PERIPHERALS INCORPORATED 5950 Clearwater Dr., Minvetonka, MN
4/20 Monday	2-4 PM	HONEYWELL AVIONICS 2600 Ridgeway Pkwy., Minneapolis, MN
4/21 Tuesday	8:30-10 AM	HONEYWELL INCORPORATED 1625 Zarthan Ave., St. Louis Pk., MN
4/21 Tuesday	10:30-12 AM	HONEYWELL INCORPORATED Olson Memorial Hwy., St. Louis Pk., MN
4/21 Tuesday	2-4:30 PM	UNISYS CORPORATION Univac Park, St. Paul, MN
4/22 Wednesday	8:30-9:30 AM	UNISYS CORPORATION 2276 Highcrest Rd., Rosenville, MN
4/22 Wednesday	10:45-12 AM	CONTROL DATA CORPORATION 4201 N. Lexington Ave., St. Paul, MN
4/22 Wednesday	2-3:30 PM	3M COMPANY 3M Center, St. Paul, MN
4/23 Thursday	9-10:30 AM	NICOLET INSTRUMENT CORPORATION 5225 Verona Rd., Madison, WI
4/23 Thursday	1-2:30 PM	G. E. MEDICAL SYSTEMS 3000 N. Grandview Blvd., Wankesha, WI
4/23 Thursday	3:15-4:30 PM	G. E. MEDICAL SYSTEMS 16800 Ryerson Rd., New Berlin, WI
4/24 Friday	9:30-11 AM	JOHNSON CONTROLS INCORPORATED 507 E. Michigan Ave., Milwaukee, WI
4/24 Friday	1-3 PM	ALLEN BRADLEY COMPANY 1201 S. 2nd St., Milwaukee, WI
4/27 Monday	9-11 AM	SUNSTAND CORPORATION 4747 Harrison Ave., Rockford, IL
4/27 Monday	1-3 PM	BARBER COLMAN COMPANY 1354 Clifford Ave., Rockford, IL
4/28 Tuesday	9-11 AM	NORTHROP DEFENSE SYSTEMS 600 Hicks Rd., Rolling Meadows, IL
4/28 Tuesday	1-2:30 PM	MOTOROLA INCORPORATED 1500 W. Dundee Rd., Arlington Hts., IL
4/28 Tuesday	3:15-4:30 PM	NORTHROP DEFENSE SYSTEMS 2525 Buffe Rd., Elk Grove Village, IL
4/29 Wednesday	9-11:30 AM	ZENITH ELECTRONIC SYSTEMS 1000 Milwaukee Ave., Glenview, IL
4/29 Wednesday	1:30-4 PM	MOTOROLA INCORPORATED 1301 E. Algonquen Rd., Naperville, IL
5/1 Friday	8:30-10 AM	AT&T TECHNOLOGIES 2600 Warrensville Rd., Lisle, IL
5/1 Friday	10:30-12 AM	TELLABS INCORPORATED 4951 Indiana Ave., Lisle, IL
5/1 Friday	2-3:30 PM	ROCKWELL INTERNATIONAL WESCOM 8245 Lemont Rd., Downers Grove, IL

DAISY IS ENGINEERING

BULLETIN:

SEMICUSTOM SOLUTIONS

Advances in system simulation yield substantially increased success rates in ASIC design.

FACT: Semicustom IC vendors report a 97–99% success rate for gate arrays, yet only 33% actually work when first tested in the system. Daisy's complete simulation environment improves design control and success rates two ways: First, array resimulation incorporating circuit timing modifications due to physical layout. Second, system level simulation where the array is simulated in the context of the target system. RESULTS: Substantially increased gate array and system design success rates.

Automatic gate array layout workstation reduces risk. Designers control costs, schedules, and ASIC performance.

Workstation-based layout on Daisy's MegaGATEMASTER™ gives the designer maximum control for better net routing and increased array utilization. Automatic, in-house layout reduces risk by avoiding vendor queues and reducing or eliminating iterations, assuring the designer of ASICs that are on time, on budget, and perform to specification when used in the final system.

CDI, NEC, RCA, add design-through-layout kits to the GATEMASTER™ Library.

California Devices, Inc.® NEC Electronics Inc.® and RCA® have each introduced automatic gate array layout design kits for the MegaGATEMASTER. Now eight ASIC vendors support physical layout on the MegaGATEMASTER, in addition to the over 55 vendors who support electrical design and simulation on Daisy workstations—and the list is growing. Designers can select from a wide "portfolio" of ASIC vendor capabilities, gate counts and technologies.

MegaFAULT: ASIC "Manufacturability Insurance."

MegaFAULT,™ Daisy's new high speed fault simulator provides the engineer with the highest confidence level in working, manufacturable silicon through reliable fault grading of test patterns required to detect potential manufacturing defects. MegaFAULT is fully integrated with Daisy design and verification tools and provides full support of ECL, CMOS, and other circuit technologies, and can also be used for fault simulations of board-level designs.

Daisy Literature Line:
1-800-556-6661
1-800-824-2385 in CA.
Department D90.

For information on Daisy's growing Semicustom Design Solutions, and the Daisy product line, call the Daisy Literature Line at 1-800-556-6661 (in California, 1-800-824-2385) Department **D90**, or write the Daisy Literature Line, 3606 W. Bayshore Rd., Palo Alto, California, 94303.

Trademarks: Daisy, MegaGATEMASTER, MegaFAULT—Daisy Systems Corp. **Registered trademarks:** California Devices, Inc. (CDI)—California Devices, Inc., NEC—NEC Electronics, Inc., RCA—RCA, Inc.

Fast-settling op amps aid in data conversion

When you use an op amp to buffer a high-speed data-conversion device, you must match the speed of the op amp to that of the D/A or A/D converter you're using. Unless your op amp's settling-time characteristics are comparable to those of the converter, the converter's fast performance will be wasted.

Charles Kitchin, Scott Wurcer, and Lew Counts,
Analog Devices Semiconductor

To take advantage of a fast DAC's speed and precision, you need to buffer it with an op amp that provides comparable performance. The op amp's dc noise characteristics mustn't bury the DAC's output, and the op amp must settle quickly, so that the voltage output you've created corresponds to the DAC's current output and is not just an artifact of the op amp's settling time.

You should pay equal attention to op-amp settling time when you're buffering the inputs of successive-approximation A/D converters. The op amp will require some finite portion of time to recover from the current switching that the A/D converter is performing at the op amp's output. If the recovery time is too long, the ADC will convert not the true buffered voltage, but a voltage that has been affected by the ADC itself.

Current-output, 12-bit D/A converters, such as the AD565A, which requires only 250 nsec to settle to within ½ LSB, have been available for several years. Very often, though, your system will require a voltage output rather than the current output that these devices provide, so you need to use an op amp to effect the necessary current-to-voltage conversion. However, many monolithic op amps require six times as long (1.5 μsec) to settle to 0.01% (½ LSB). Using one of these op amps would be counterproductive; you'd effectively waste the fast performance of the converter.

You can buffer the DAC without wasting its performance by matching the specifications of the buffer amplifier to those of your DAC. **Fig 1** shows an AD565A DAC using an AD711 op amp as an output buffer. The AD711's performance is comparable to that of the DAC (see **box,** "The AD711 family of op amps"). The DAC's output resistance is modeled by the 8-kΩ resistor connected between the DAC's output and the analog common terminals. The 10-pF capacitor connected between the summing junction and the output of the amplifier compensates for both the DAC's output capacitance and the amplifier's 5-pF input capacitance. Note, however, that although this schematic uses a 10-pF capacitor (a standard fixed value) for C_1, a 7.8-pF capacitor would provide the fastest settling.

The scope photo in **Fig 2** (pg 188) shows the output voltage of the AD711 for a transition from +10 to 0V. The vertical scale of the photo is 5 mV/div, which translates to 2 LSB/div. Note that the output settles to within ½ LSB of its final value in 1 μsec.

The 8-kΩ output resistance of the DAC is shunted by

An op amp used as a DAC buffer must settle quickly, so that its voltage output corresponds to the DAC's current output and isn't affected by the op amp's settling time.

the 9.95-kΩ bipolar offset resistor connected in series with the 100Ω trim resistor. This combination produces an effective output resistance of 4.4 kΩ. When you use the full 10-kΩ feedback resistance available in the DAC to obtain a 20V output span, the dc noise gain is 3.25 because the noise is modeled at the positive input of the op amp and is therefore amplified by the transfer function $1+(R_F/R_{OUT})$. The worst-case offset drift of the op amp, 10 μV/°C, will therefore contribute 32.5 μV/°C to the output of the amplifier. Over the full 0 to 70°C temperature range, offset drift will cause a 700-μV error voltage to appear at the amplifier's output. This error voltage amounts to less than 0.3 LSB for a 12-bit DAC with a 20V output swing.

The initial offset voltage of the op amp, specified at 0.5 mV, would contribute 1.65 mV to the output if it weren't trimmed out with the bipolar-offset-adjust resistor, R_1. The additive effects of offset drift and an initial, untrimmed, offset voltage could present as much as 2.35 mV at the output of the amplifier. This offset voltage is greater than ½ LSB, and it effectively negates the benefits of the fast-settling 12-bit converter. If you carefully trim out the initial offset voltage, however, you can take advantage of the DAC's 12 bits of accuracy.

Because the noise gain is greater than 2.0, you can reduce the settling time of the above circuit to 500 nsec by substituting an AD744 for the AD711. The AD744 features a 50V/μsec slew rate and a 12-MHz bandwidth. When you use the AD744, you may substitute a smaller feedback capacitor (between pins 2 and 6 of the op

Text continued on pg 188

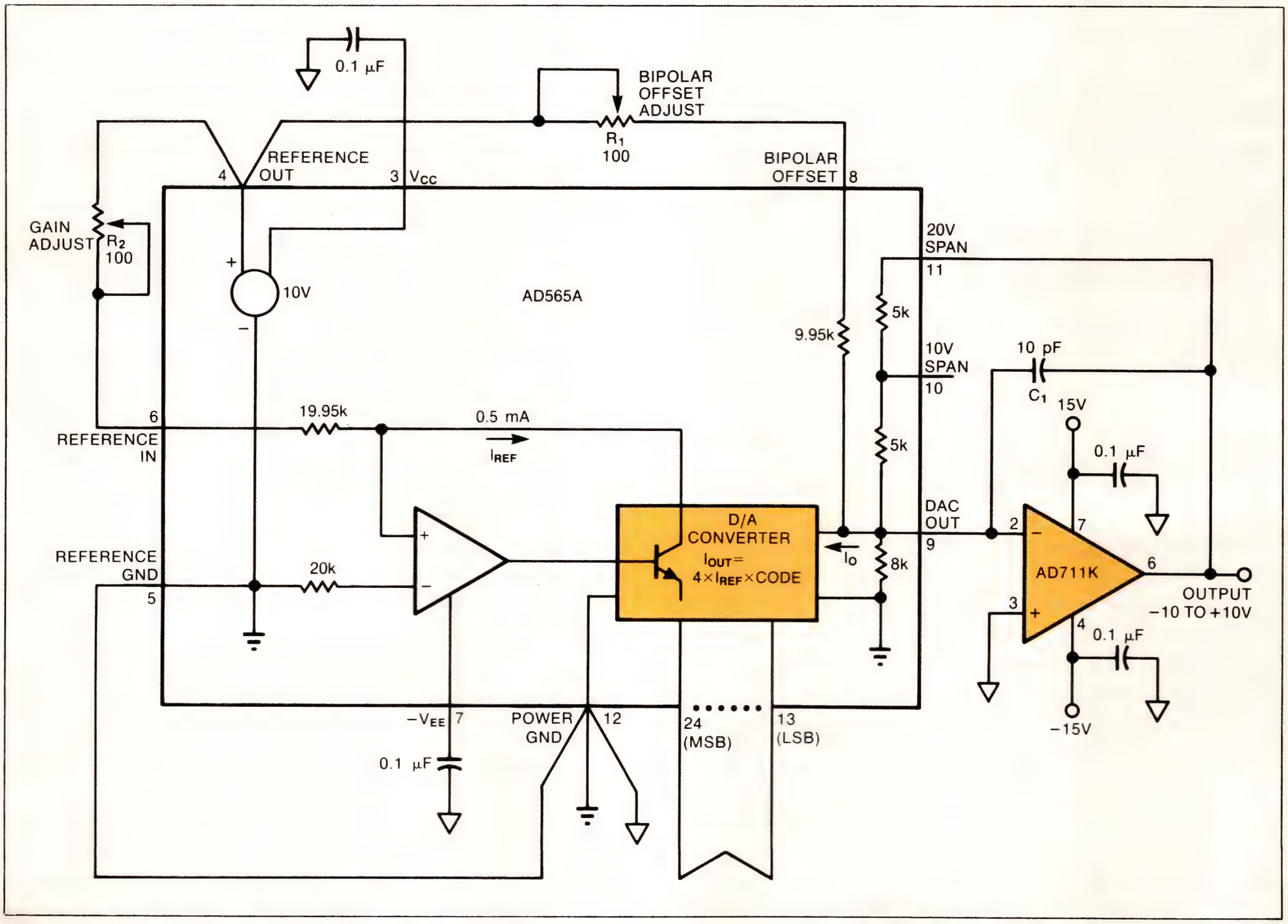
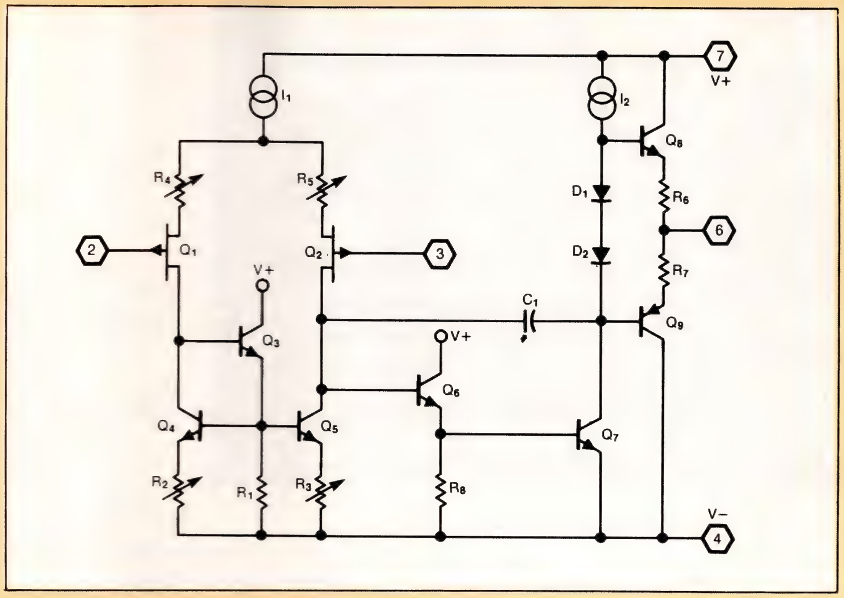


***Fig 1—To take advantage of the speed of a fast D/A converter** (the AD565A), you can use an AD711 op amp to provide output buffering.*

The AD711 family



A 2-stage BiFET op-amp architecture *characterizes the AD711 family of op amps. The amplifiers are fabricated with a junction-isolated and JFET process.*

KEY SPECS OF THE AD711 OP-AMP FAMILY

PARAMETER	AD711JN	AD711KN	AD744JN	AD744KN
0.01% SETTLING TIME (10V STEP, G=1) TYP (μSEC)	1	1	0.5	0.5
MAX (μSEC)	1.8	1.8	0.8	0.8
MIN SLEW RATE (V/μSEC)	16	18	45	50
MIN BANDWIDTH (MHz)	3.0	3.4	10	12
1-kHz VOLTAGE NOISE (nV/√Hz)	18	18	18	18
MAX OFFSET VOLTAGE (mV)	2.0	0.5	2.0	0.5
MAX OFFSET VOLTAGE DRIFT (μV/°C)	20	10	20	10
CMRR (dB MIN ±10V)	76	80	76	80
MAX SUPPLY CURRENT (mA)	3.4	3.0	4.5	4.0
STABLE AT MINIMUM GAIN OF	1.0	1.0	2.0	2.0
PRICE (100)	$0.80	$1.90	$1.90	$2.75

When operated as a follower or inverter that has a gain of unity or greater, the AD711 amplifier is compensated for stable operation. The device settles to within 0.01% of final value in 1 μsec typ, and it has a small-signal bandwidth of 4 MHz. The AD712, a dual version of the AD711, has similar specifications but also provides the sort of close parametric matching that results when you place two devices on the same die. The AD744 is internally compensated for noise gains of two or greater and settles in 0.5 μsec to within 0.01% of final value with a 10V step.

The amplifiers in the AD711 family are fabricated with a junction-isolated and JFET process. After initial processing, the manufacturer nulls the offset voltage and offset-voltage drift of each amplifier at the wafer level by laser-trimming several on-chip thin-film resistors. The manufacturer trims the input-stage operating current of each amplifier to reduce the effect of process variation on the op amps' ac performance. By using a standard linear process, the manufacturer avoids the potential problems associated with the dielectric-isolation process, which can cause dielectric absorption, thereby degrading settling characteristics.

The AD711 uses a 2-stage BiFET op-amp architecture. The first stage consists of a differential FET input section (Q_1 and Q_2), which operates with a total current of 400 μA and has a transconductance of approximately 400 μS. The combination of this current level and the input FETs provides both adequate transconductance and low noise. The manufacturer adjusts V_{OS} by laser-trimming small resistors in the source of the input-stage FETs.

The bias current for the input stage is generated by a FET current source, I_1. Within I_1, current is multiplied by a split-collector pnp transistor that is cascoded by a second FET. This configuration provides a current source that is decoupled from power-supply and common-mode variations. The input stage operates directly into a current mirror, transistors Q_3 and Q_4.

The integrator-stage transistors, Q_6 and Q_7, run at 100 μA and 1 mA, respectively. All transistors in the signal path are striped-geometry devices. This geometry maximizes the gain-bandwidth product, F_T. Further, in this configuration, transistor Q_7 operates without degeneration. All these factors contribute to the creation of a tightly controlled integrator loop that has high bandwidth. The integrator loop reduces the phase shift through the amplifier.

Symmetrical current-limiting resistors on the class AB output stage combine with a 0.5-mA idle current to provide a harmonic-distortion figure of less than 0.0003% when the op amp's output is 3V rms, R_1 is 2 kΩ, and the test frequency is 1 kHz.

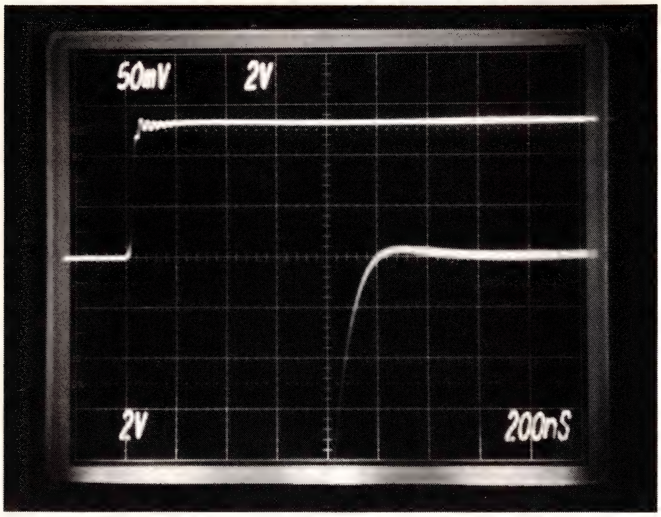


***Fig 2—The AD711 op amp's output** (bottom trace) settles to ½ LSB of final value in less than 1 µsec (sweep speed is 200 nsec/div) for a 10 to 0V step. The display shows the final portion of the output transient at an equivalent sensitivity of 5 mV—or 2 LSBs—per division. The top trace is the logic transition that results in the amplifier's output excursion.*

amp), to provide the fastest possible settling time. A 1- to 10-pF air-variable trimmer capacitor is recommended for this purpose. Keep in mind that some ceramic trimmer capacitors exhibit very high dielectric absorption. Dielectric absorption causes the capacitor to exhibit a "memory effect." In a memory effect, although the voltage across the capacitor may change instantaneously to the value that you desire, the voltage will then tend to droop or relax to a voltage that's between the desired voltage and the previous voltage across the capacitor.

In general, you can represent the buffer amp as an ideal integrator. Using this model, you can determine the most suitable value for the feedback capacitor. **Fig 3** shows a Norton-equivalent simplified model in which the op amp is configured as a current-output-DAC buffer. You can accurately predict the small-signal behavior of the circuit with the equation

$$\frac{V_{OUT}}{I_O} = \frac{-R}{\dfrac{R(C_F + C_X)}{\omega_O}s^2 + \left(\dfrac{G_N}{\omega_O} + RC_F\right)s + 1}, \qquad (1)$$

where $\omega_O/2\pi$ equals the op amp's unity-gain frequency and G_N, the noise gain of the circuit, equals $1+(R/R_O)$. When you solve **Eq 1** for C_F, you obtain

$$C_F = \frac{2 - G_N}{R\omega_O} + \frac{2\sqrt{RC_X\omega_O} + (1 - G_N)}{R\omega_O}. \qquad (2)$$

In these equations, C_X is the total capacitance appearing at the inverting terminal of the op amp. In other words, C_X is the sum of the DAC's output capacitance and the op amp's input capacitance. **Eqs 1** and **2** describe the output of the system when the op amp's slew rate and other nonlinear effects are ignored.

When you replace R_O and I_O with their Thevenin equivalents, V_{IN} and R_{IN}, you obtain the general-purpose inverting amplifier shown in **Fig 4**. In this inverting amplifier, C_X is the op amp's input capacitance.

In either case, C_X changes the system response from a 1-pole to a 2-pole response. The additional pole increases settling time by introducing ringing in the op

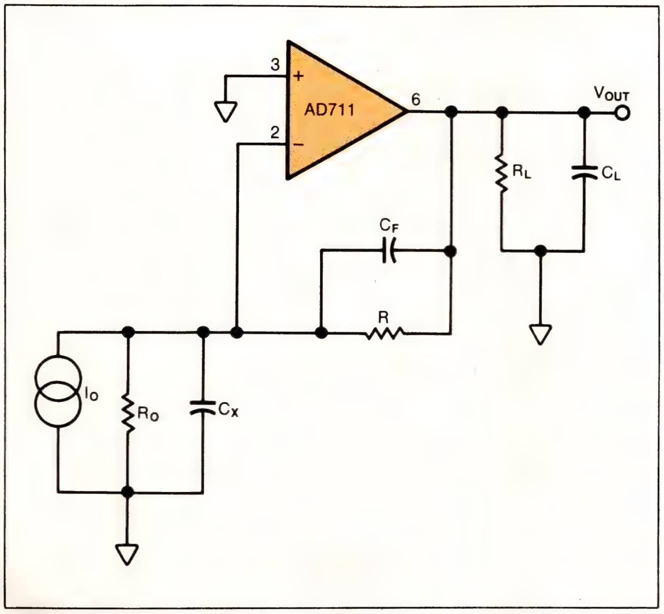


***Fig 3—When you operate** the AD711 as a current-output DAC buffer, you can use this simplified model for circuit analysis.*

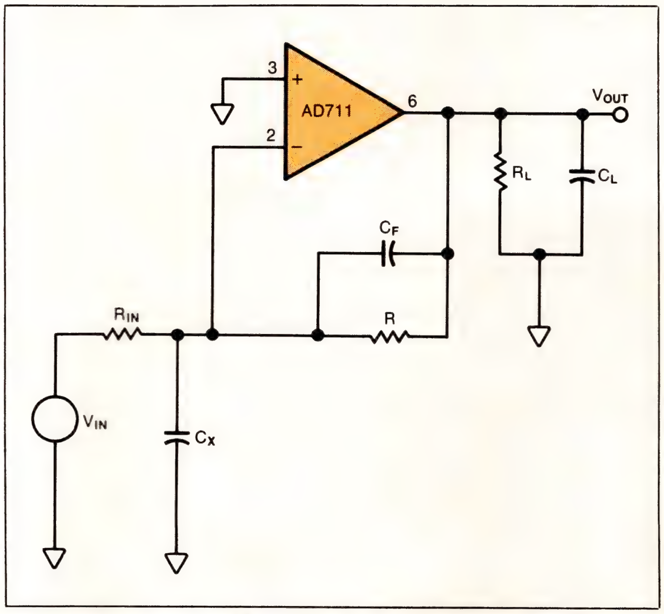


***Fig 4—You can use this model for analysis** of an op amp that's operating as an inverting amplifier.*

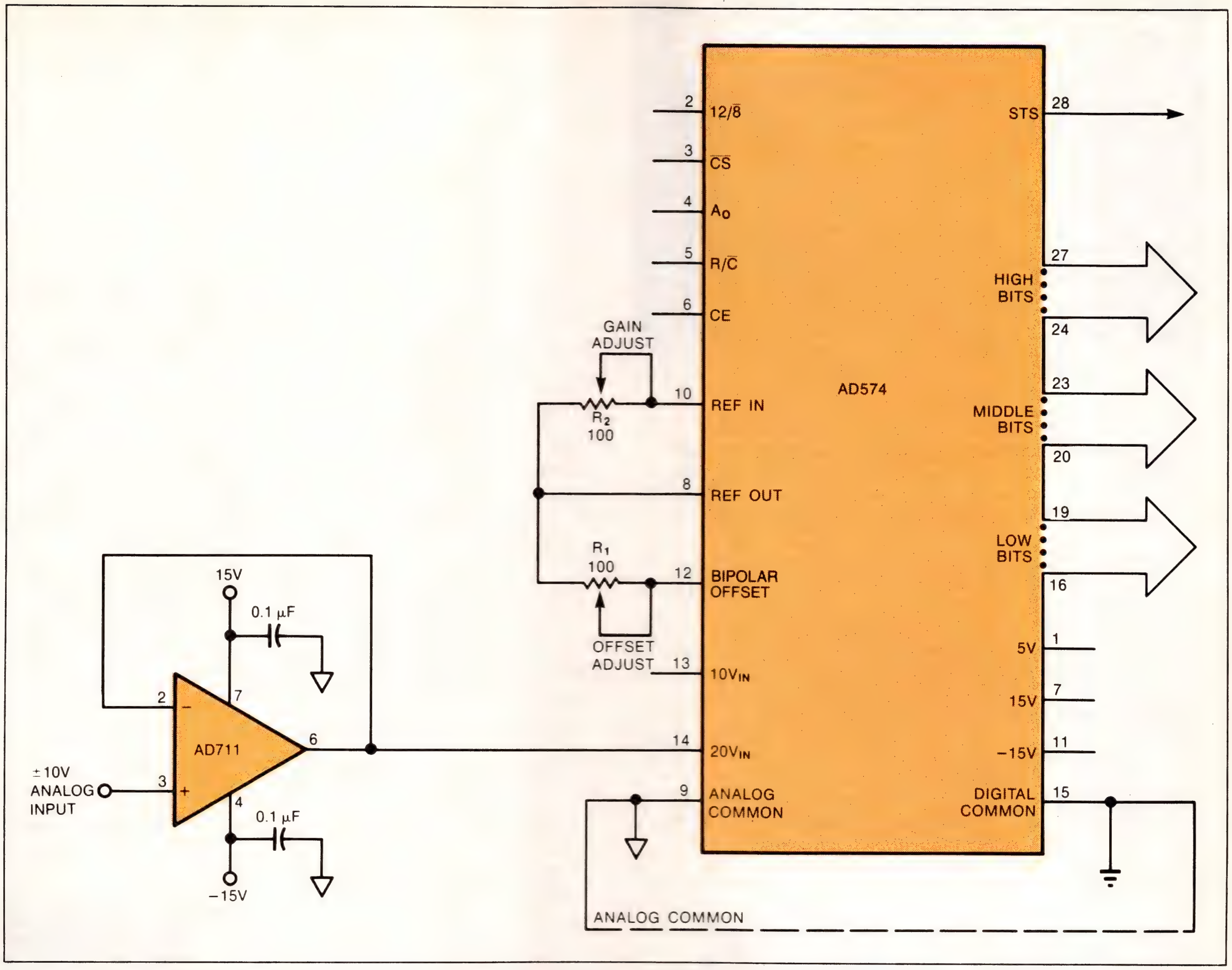
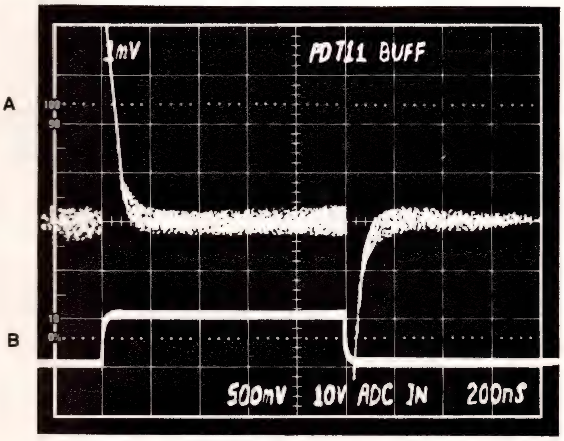


***Fig 5—To buffer the input of a successive-approximation A/D converter,** you often need an op amp. In this circuit, an AD711 op amp acts as a unity-gain buffer on the input of an AD574 A/D converter.*

amp's output. Because you can estimate C_X with reasonable accuracy, you can use **Eq 2** to select a small capacitor, C_F, to cancel the input pole and minimize the amplifier's settling time.

Buffer amplifiers are also employed in data-acquisition systems, and one of the most demanding of these applications is that of buffering successive-approximation A/D converters. It's just as important for the op amp's performance to match that of the converter in this application as it is in the DAC-buffer application. **Fig 5,** for example, illustrates the connection of an AD711 as a unity-gain buffer at the input of an AD574 successive-approximation A/D converter.

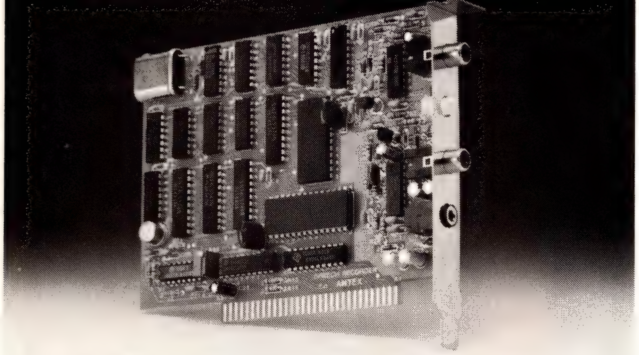
A successive-approximation A/D converter compares an input current, which represents the signal being digitized, to a portion of the reference current. The reference current is developed with the use of a diode voltage reference. This voltage may deviate from its nominal value by several hundred millivolts; as a consequence, the A/D converter's input current is modulated. This input-current modulation occurs because the measuring device both effects and affects the measurement; to eliminate the modulation, you need to buffer the input to the converter.



TRACE	VERTICAL	HORIZONTAL
A	1 mV/DIV	200 nSEC/DIV
B	500 mV/DIV	200 nSEC/DIV

***Fig 6—The AD711 op amp's output** (trace A) recovers in less than 200 nsec from a 2-mA source-current excursion. Trace B shows the logic transition that causes the current swing.*

CAN WE TALK



Sing it. Say it. Play it. The VP600 Voice Processor converts real-time audio or cassette inputs into digital data for recording on your IBM PC/XT/AT or compatible. And when it comes to playback, you have random access to flawless, natural sounding audio. It's that simple.

Just plug it into any short slot, load menu-driven software and you have up to 7.2 MB/hr of digital audio from your PC. It's that easy.

You can use it for telecommunications store and forward... security, process control, entertainment sys., point-of-sale or any other voice response application.

Call 1-800-621-0849 X 350 for the facts on this exciting new voice module that will make your PC talk.

IBM PC/XT/AT are designations of IBM Corp.

ANTEX ELECTRONICS
16100 S. Figueroa St. • Gardena, CA 90248 • (213) 532-3092 • TWX 910-344-7381

CIRCLE NO 28

EDN NEWS

EDN NEWS

DSP Board Fits IBM PC

Power MOSFET Makers Boost Electrical Specs

HOT NEWS OF PRODUCTS, TECHNOLOGY, AND CAREERS

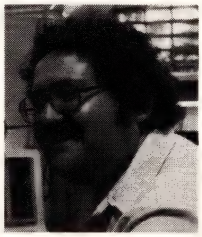
Even with an op-amp buffer in place, the input to the A/D converter will be modulated by a change in the diode reference voltage. Consider, for example, the case in which the input current varies by 300 μA. The output impedance of an op amp at high frequencies approaches its open-loop value. This value, which is due mainly to current-limiting resistors in the op amp's output stage, is generally 25Ω. The voltage shift at the input to the A/D converter would, in this case, be 300 $\mu A \times 25\Omega$, or 7.5 mV.

In this example, the ADC is introducing a significant error, but if the speed of the A/D conversion and the bandwidth of the op amp are well matched, the output of the op amp will return to the correct value before the converter makes its comparison.

The scope photo in **Fig 6** shows the worst-case recovery time for **Fig 5**'s circuit. The top trace is the input voltage to the ADC. As you can see, the op amp returns to nominal voltage in less than 200 nsec. **EDN**

Authors' biographies

Charles Kitchin is a technical-support specialist at Analog Devices Semiconductor Division (Wilmington, MA), where he has been employed for the last 10 years. He previously worked at KYBE Corp (Waltham, MA) and Boston radio stations WMEX and WCRB. Chuck graduated with an ASET from Wentworth Institute in Boston, and he now studies in the evening division at the University of Lowell in Lowell, MA. His spare-time activities include astronomy, jogging, and food and wine appreciation.

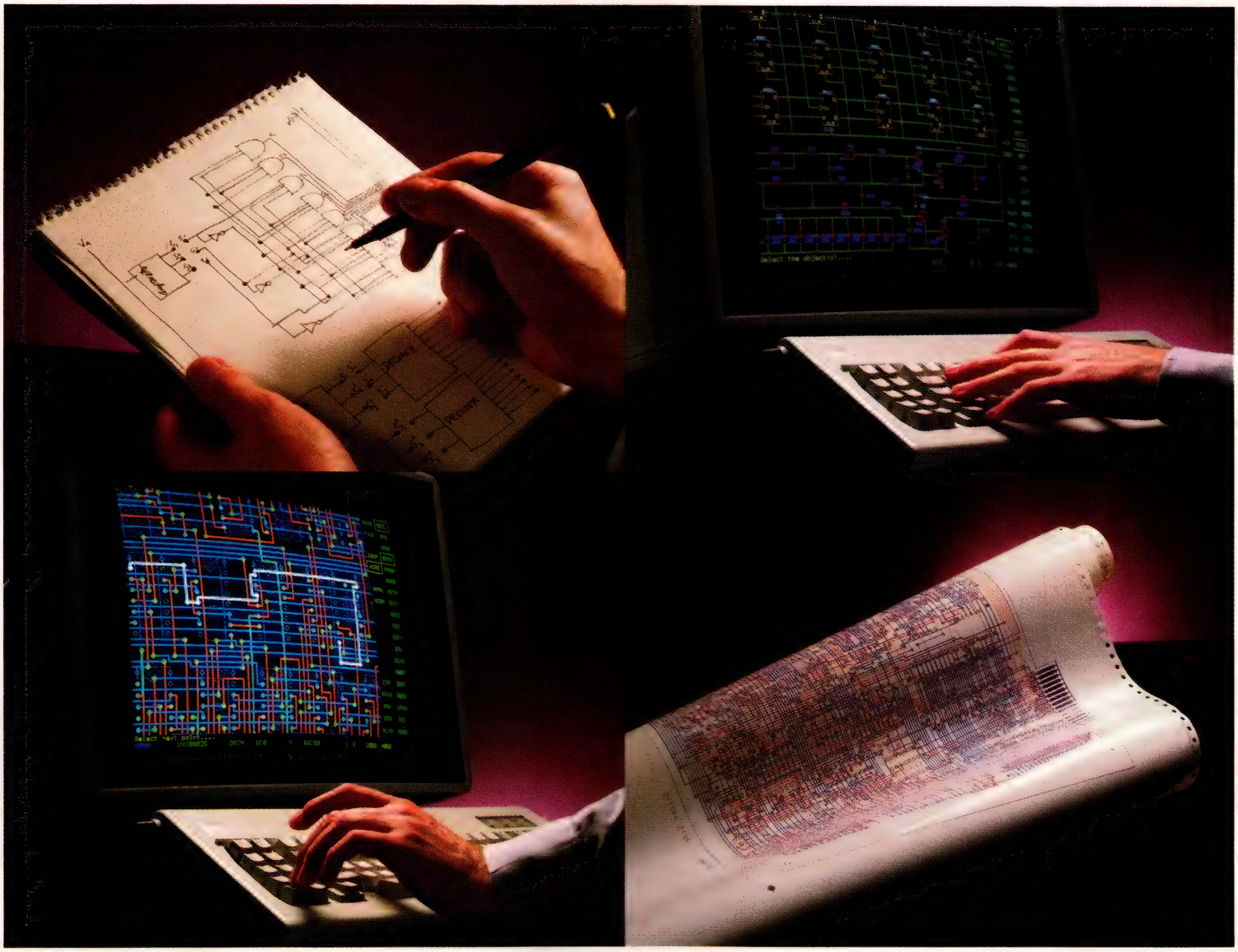


Scott Wurcer is a senior design engineer at Analog Devices Semiconductor, where he has worked for 12 years. He holds a BSEE degree from the Massachusetts Institute of Technology and is a member of IEEE and AES.

Lew Counts, manager of linear engineering and a Division Fellow at Analog Devices Semiconductor, has worked at the company for 15 years. A member of the IEEE, he holds a BSEE degree from the Massachusetts Institute of Technology. His hobbies are cycling and cross-country skiing.

Article Interest Quotient (Circle One)
High 479 Medium 480 Low 481

Total Integration.
From Concept to Prototype.



P-CAD's newest generation CAE/CAD design tools can take you all the way from concept to finished design on one system. That's why it's the Benchmark against which other design automation products are being judged.

FIRST, COMPARE FUNCTION.

P-CAD provides a true end-to-end PCB design solution. From interactive schematic capture, through automatic component placement and routing of trace interconnections and beyond, to paper tapes for NC drilling machines. All the way from concept to prototype on a single, integrated system.

NEXT, COMPARE PRICE.

P-CAD's modular PCB design software runs on a standard IBM PC-XT, AT,™ or compatible computer. So you get the functionality of a high-priced workstation at a fraction of the cost.

THEN, COMPARE OUR FEATURES WITH EVERYONE ELSE.

Other CAE/CAD systems give you some of P-CAD's features. Only P-CAD has them all. PLD and semi-custom IC design, in-circuit simulation, and comprehensive libraries are all available on a single P-CAD PC-based system.

NOW, COMPARE COMPANIES.

P-CAD's customer commitment doesn't stop once your system is delivered. Our comprehensive product documentation, customer service hotline, on-site and localized training programs, active user's group, electronic bulletin board, quarterly newsletter, and 75-office worldwide network make us the benchmark in customer support.

For more information, or a product demonstration, call P-CAD toll-free at (800) 523-5207 (in CA: (800) 628-8748; Internationally: (408) 971-1300). Or write: Personal CAD Systems Inc., 1290 Parkmoor Ave., San Jose, CA 95126. TELEX 3717199. (P-CAD products also available for rent or lease from US Instrument Rentals.)

And put the benchmark to work for you.

© 1986, Personal CAD Systems, Inc. IBM, PC, XT, and AT are registered trademarks of International Business Machines Corp.

p-cad™
THE BENCHMARK

CIRCLE NO 99

Sony's 256K SRAMs are taking current retention to a new low.

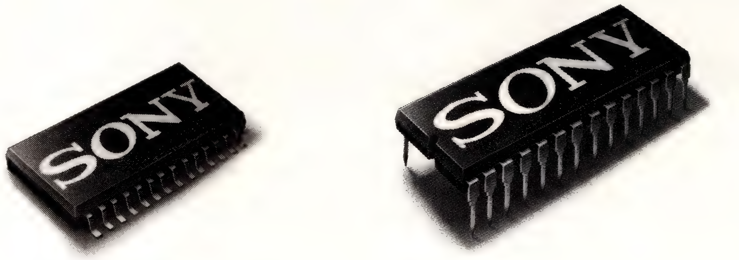
And they're available now, to help your designs reach new peaks in performance.

Choose from a complete range of Sony 256K SRAMs, available in numerous speeds and data retention currents, in either DIP or SOP packaging.

For super-low data retention current, consider our CXK58256P-10LL/12LL, with just 10 μA data retention current. Or our soon to be released CXK58255P-45/55/70 at 5 μA, and CXK58255P-45L/55L/70L at just 2.5 μA.

SONY SRAM DEVICES			
PART NUMBER	ORGANIZATION	SPEED (ns)	PACKAGE
CXK5814P—35L/45L/55L	2K x 8	35/45/55	300 mil DIP
CXK5816PN—10L/12L	2K x 8	100/120	600 mil DIP
CXK5816M—10L/12L	2K x 8	100/120	SOP*
CXK5416P—35L/45L/55L	4K x 4	35/45/55	300 mil DIP
CXK5864AP—70L/10L	8K x 8	70/100	600 mil DIP
CXK5864AM—70L/10L	8K x 8	70/100	SOP*
CXK5864PN—12L/15L	8K x 8	120/150	600 mil DIP
CXK5864M—12L/15L	8K x 8	120/150	SOP*
CXK5464P—45L/55L/70L	16K x 4	45/55/70	300 mil DIP

*Small Outline Package



No matter which SRAMs you choose, you also benefit from our immediate delivery. Plus the quality, reliability and performance found in all Sony products.

By calling today, you'll get all the details—plus a free data book on our complete line of Sony SRAMs.

So call (213) 373-9425, or write Sony Corporation of America, Component Products Division, 23430 Hawthorne Blvd., Suite 330, Torrance, CA 90505.

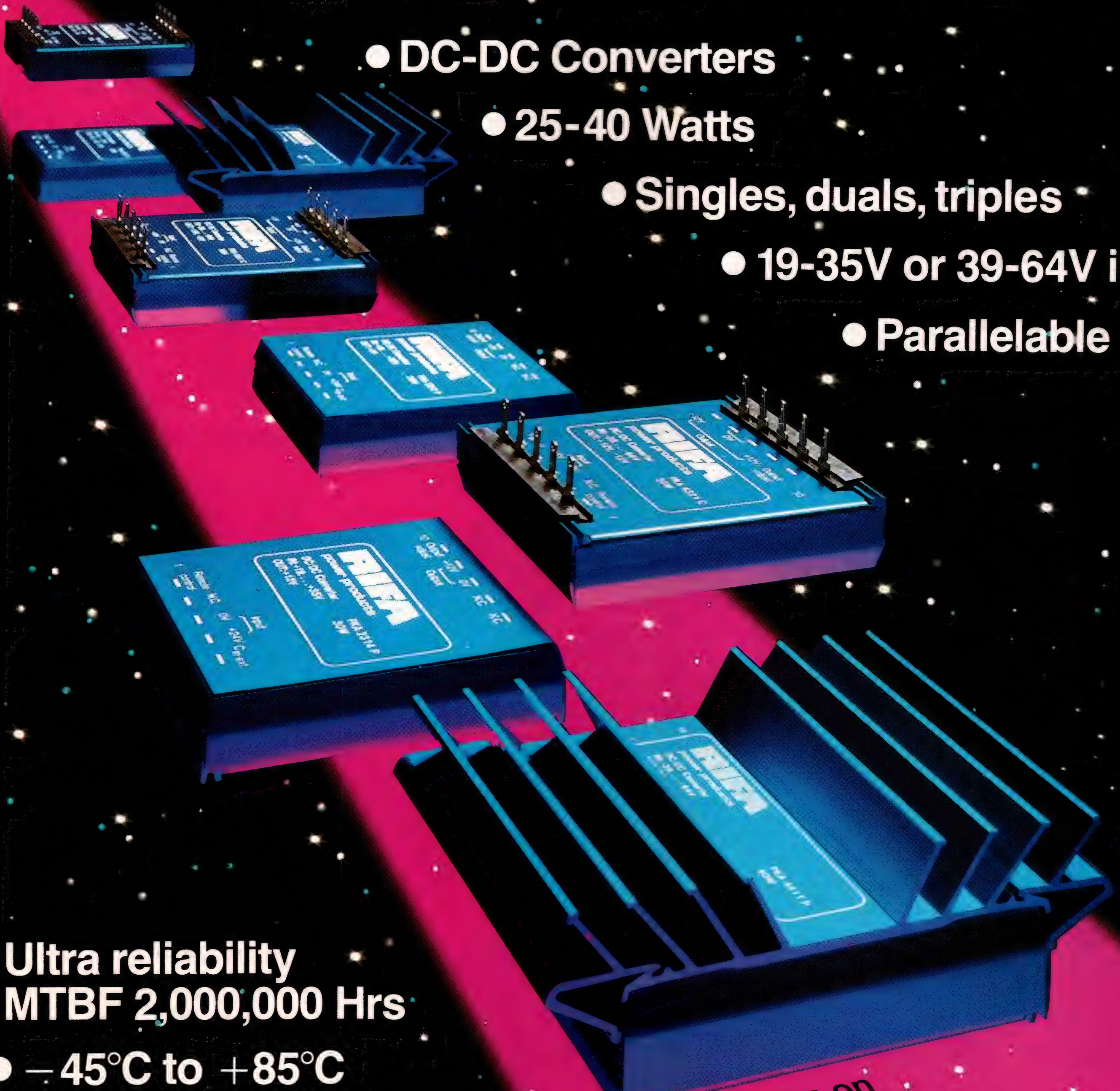
Sony SRAMs. Setting higher performance standards with lower data retention current.

PERFORMANCE OF 32K X 8 SRAM					
PART NUMBER	PROCESS	SPEED (ns)	PACKAGE	DATA RETENTION CURRENT (MAX)	DATA RETENTION CONDITION
CXK58256P—10L/12L	MIX MOS	100/120	600 mil DIP	50 μA	0 to 70°C
CXK58256MF—10L/12L	MIX MOS	100/120	SOP	50 μA	0 to 70°C
CXK58256P—10LL/12LL	MIX MOS	100/120	600 mil DIP	10 μA	0 to 70°C
CXK58255P—45/55/70	FULL CMOS	45/55/70	600 mil DIP	5 μA	−30 to 85°C
CXK58255P—45L/55L/70L	FULL CMOS	45/55/70	600 mil DIP	2.5 μA	−30 to 85°C

SONY®

Light years ahead

- DC-DC Converters
- 25-40 Watts
- Singles, duals, triples
- 19-35V or 39-64V input
- Parallelable



- Ultra reliability MTBF 2,000,000 Hrs
- −45°C to +85°C without derating
- Isolated and nonisolated versions available

For information on
DC-DC converters
Please circle 64

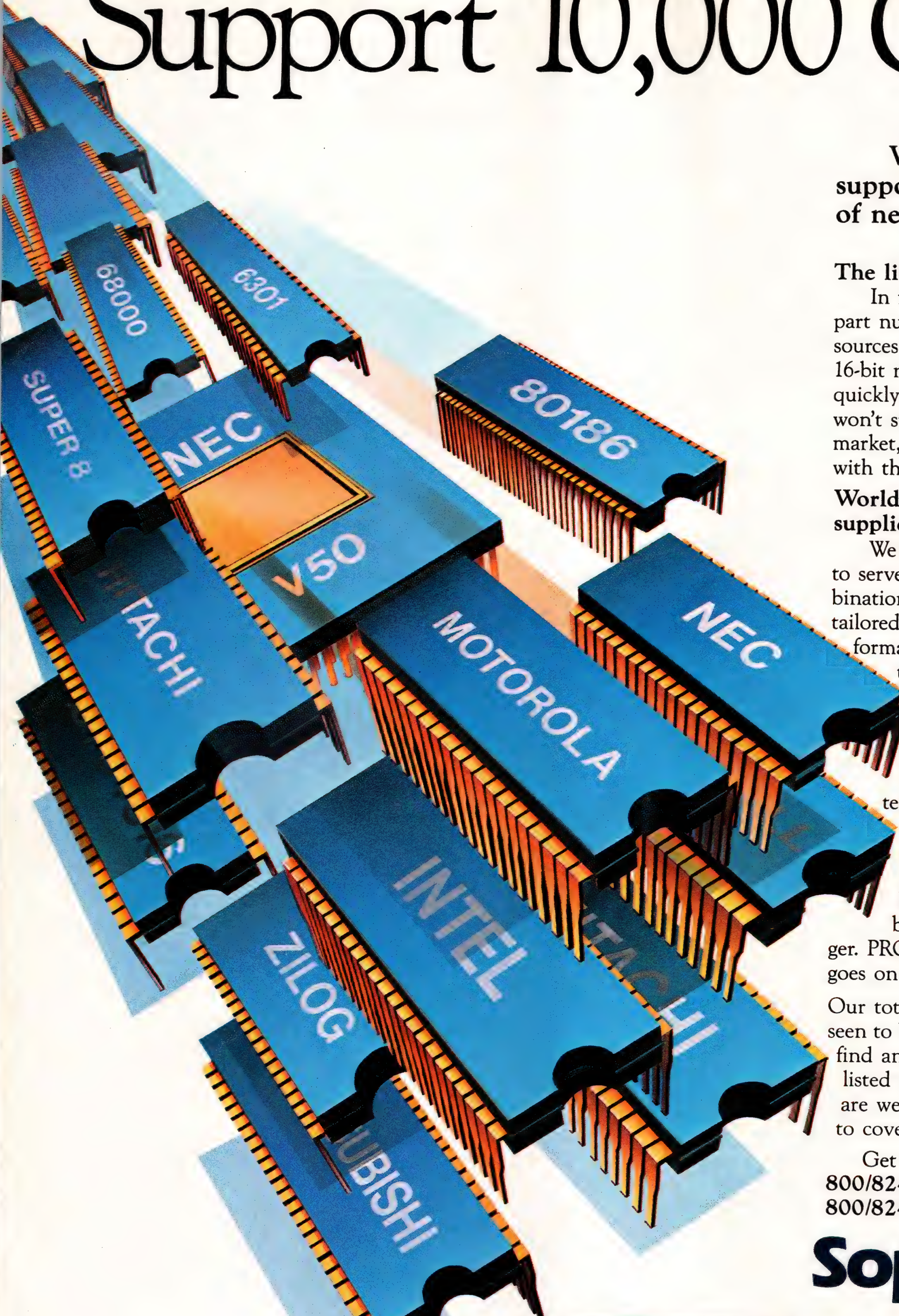
For information on
AC-DC Eurocard SMPS 60-100W
Single, Dual and Triple outputs
Please circle 103

RIFA Inc
Greenwich Office Park 3
P.O. Box 3110
Greenwich, CT 06836-3110
(203) 625-7300

RIFA

quality for the future

Support 10,000 Chips



We're dedicated to supporting a constant stream of new microprocessors.

The list keeps growing.

In fact, when we started to list all part numbers, dash numbers, primary sources, and second sources for 8- and 16-bit microprocessors, the number quickly climbed to over 10,000. And it won't stop. As new devices enter the market, Sophia Systems will be ready with the support tools you'll need.

World's fastest growing MDS supplier.

We have the design support tools to serve your needs. The proper combination of hardware and software tailored to maximize the price and performance previously only available in the very high-end systems. And it's portable.

Built-in power.

We've truly put together a stand-alone development system that takes care of business. No wait state emulation. Symbolic debugger. Relocatable macro assembler. Programmable breakpoints. 2K to 4K trace buffer. Logic analyzer type trigger. PROM programmer. And the list goes on.

Our total system approach has to be seen to be appreciated. To put it simply, find any 8- or 16-bit microprocessor listed in the IC Master, chances are are we have the development support to cover it.

Get the help you need today, call **800/824-9294**. In California, call **800/824-6706**.

Sophia systems™

Universal Development Systems

U.S. & European Headquarters:
Sophia Computer Systems, Inc.
3337 Kifer Road
Santa Clara, CA 95051

Corporate Headquarters:
Sophia Systems Co., Ltd.
NS Bldg. 2-4-1
Nishishinjuku, Shinjuku-ku
Tokyo, 160 Japan
03-348-7000

©1986 Sophia Computer Systems
Sophia Systems is a trademark of Sophia Computer Systems, Inc.

CIRCLE NO 101

Combine C and assembly language for the 8086/88

You can write programs containing both C and assembly-language code for designs based on the 8086/88 μP. To write such programs, you must make your C and assembly-language routines compatible with each other.

William C Warner, *Consultant*

For designs incorporating an 8086/88, you may want to write all of a project's routines in a high-level language, such as C. However, some critical routines will invariably demand the speed and compactness of assembly language. To take advantage of the benefits of both languages, you can combine both types of code in your programs by writing assembly-language and C routines that are compatible. Your assembly-language routines must be able to call C routines, and your C routines must be able to call assembly-language routines.

To make C routines and assembly-language routines compatible, you must first know the conventions for the code your C compiler generates. Every compiler follows its own particular conventions for register usage, parameter passing, data returns, and routine calling. The assembly-language routines you write must follow those conventions.

In all C compilers, when a called routine returns control to a calling routine, certain registers must come back with their contents unaltered. These registers always include the code-segment (CS), stack-segment (SS), stack-pointer (SP), and base-pointer (BP) registers (**Fig 1**). When your C compiler calls an assembly-

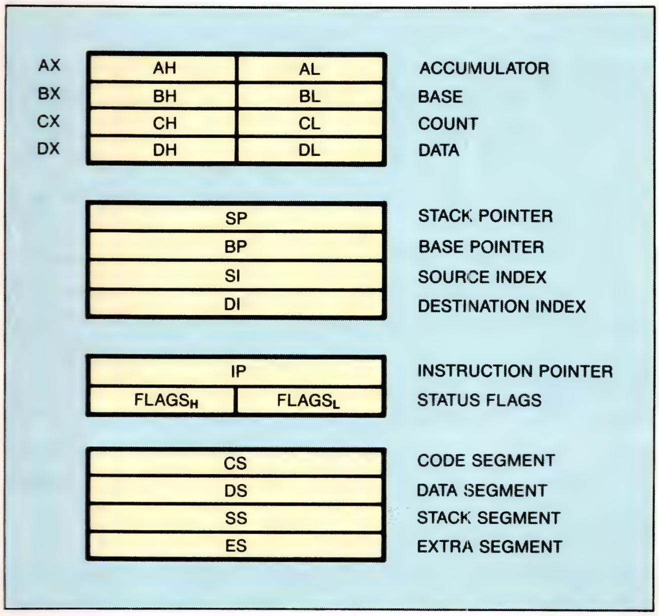
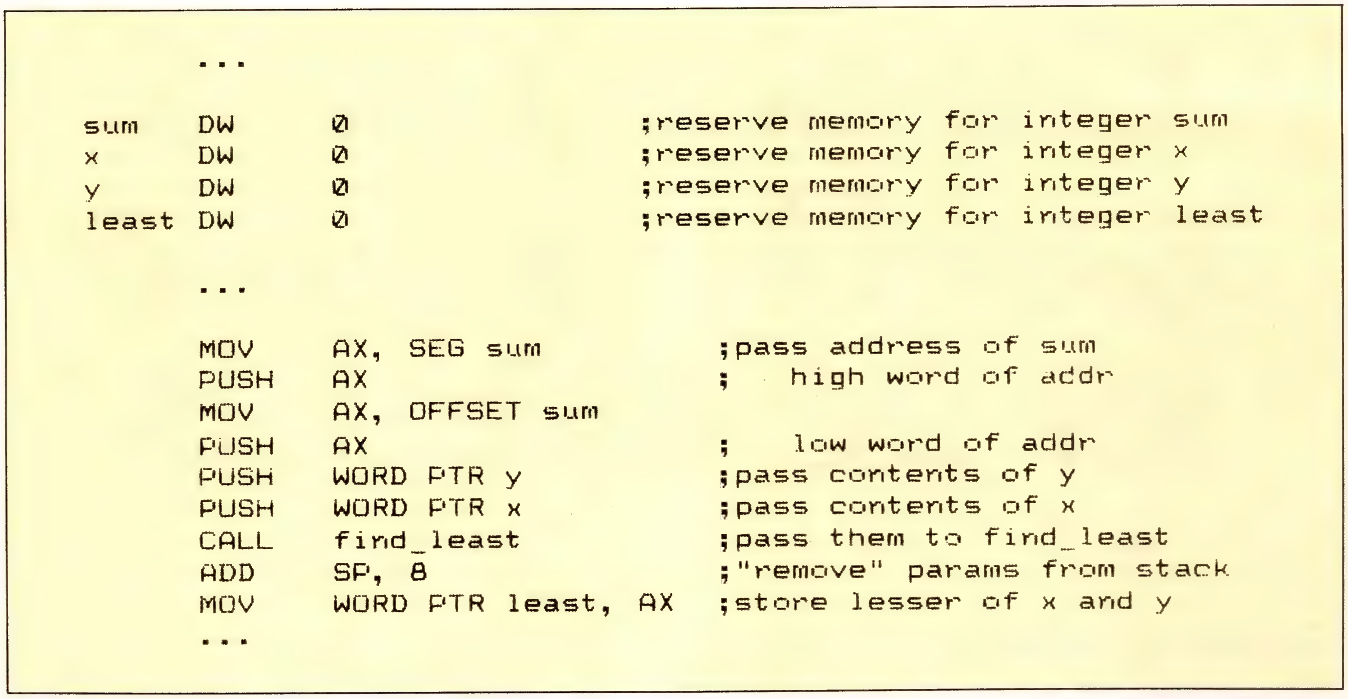


*Fig 1—**All C compilers require certain** registers to come back with their contents unaltered when a called routine returns control to a calling routine. Of all the 8086/88 registers (shown here), the code-segment (CS), stack-segment (SS), stack-pointer (SP), and base-pointer (BP) registers must always return unaltered.*

To write compatible assembly-language and C routines, you must first know your C compiler's conventions for the code it generates.



```
        ...

sum     DW      0                       ;reserve memory for integer sum
x       DW      0                       ;reserve memory for integer x
y       DW      0                       ;reserve memory for integer y
least   DW      0                       ;reserve memory for integer least

        ...

        MOV     AX, SEG sum             ;pass address of sum
        PUSH    AX                      ;    high word of addr
        MOV     AX, OFFSET sum
        PUSH    AX                      ;    low word of addr
        PUSH    WORD PTR y              ;pass contents of y
        PUSH    WORD PTR x              ;pass contents of x
        CALL    find_least              ;pass them to find_least
        ADD     SP, 8                   ;"remove" params from stack
        MOV     WORD PTR least, AX      ;store lesser of x and y
        ...
```

Fig 2—This assembly-language code *follows the rules for a C compiler. The code passes parameters by pushing them (from right to left) onto the stack, calls the find_least() subroutine, removes the parameters from the stack, and stores the integer returned by find_least().*

language routine, therefore, that routine must return at least these four registers unaltered.

The code-segment register never requires special handling. In the large register model (the model in which the 8086/88 addresses more than 64k bytes of memory), the code-segment register is automatically restored, from the stack, when a routine returns. In the small model (in which addressing stays within a 64k-byte page), no reason exists to change the code-segment register.

Depending on the C compiler you use, your assembly-language routines may have to preserve the contents of other registers as well. For example, the Mark Williams C compiler requires routines to preserve the source-index (SI) and destination-index (DI) registers. According to the Lattice compiler's convention, the data-segment (DS) and extra-segment (ES) registers must be unchanged. Your compiler's manual will spell out its conventions.

You won't always be able to avoid using some or all of the registers that must be preserved. To ensure that the registers return unaltered, you can make the called routine save the registers on the stack immediately when it begins executing and then restore them just before it exits. Routinely saving all of the registers that must be preserved is a good idea, even if a particular routine does not employ them all, because during subsequent program modifications, you might change the registers that the routine uses. Always pushing the registers onto the stack in the same order is also a good practice.

When you have an assembly-language routine call a C routine, however, you don't have to modify your C code. You can always count on a C routine to return unaltered all the registers on the compiler's list of registers to be preserved.

Your assembly-language routines must also adopt the compiler's conventions for returning data. For each data type (character, short integer, long integer, floating-point number, pointer, etc), there is only one correct way to return a datum. A routine returns a datum by putting the datum in the appropriate register and executing a return. To date, most C compilers employ register AL for returning characters and register AX for returning short integers. For other data types, different compilers use different conventions. For example, the Mark Williams C compiler returns long integers, floating-point numbers, and pointers in DX:AX; DX holds the high word. The Lattice C compiler returns these data types in AX:BX with the high word in AX.

All code generated by C compilers for the 8086/88

```
; Routine:  find_least
;
; This routine is callable from C as follows:
;
;    int least, x, y, sum;
;
;    least = find_least(x, y, &sum);
;
; This routine is passed two integers and the address of an
; integer.  It returns the lesser of the two integers and
; stores the sum of the two at the address passed in.
;
; This routine expects its parameters on the stack, just above
; the return address, and pushed in the order: &sum, y, x.  It
; returns the lesser of x and y in the AX register, and stores
; the sum of x and y at &sum.
;
; This routine is appropriate for use in large model only.


find_last:  PUSH  BP    ;preserve regs as required by compiler
            PUSH  DI
            PUSH  SI

            MOV   BP, SP

            MOV   CX, WORD PTR [BP+10]    ;get parameter x
            CMP   CX, WORD PTR [BP+12]    ;compare y
            JLE   find_last1              ;jmp if x <= y

            MOV   CX, WORD PTR [BP+12]    ;else, get y

find_last1: MOV   AX, WORD PTR [BP+10]    ;get x
            ADD   AX, WORD PTR [BP+12]    ;add y

            LDS   BX, DWORD PTR [BP+14]   ;get addr of sum
            MOV   WORD PTR [BX], AX       ;store x+y there

            MOV   AX, CX                  ;return lesser in AX

            POP   SI                      ;restore preserved regs
            POP   DI
            POP   BP
            RET
```

Fig 3—The routine in Fig 2 can call *this routine, find_least(). This routine takes the two integers and the address of an integer from the stack, returns the lesser of the two integers, and stores the sum of the two integers at the address.*

When it begins executing, a called routine should save the registers on the stack immediately and restore them just before exiting.

passes parameters on the stack. The C routines push the parameters onto the stack in the order in which you've listed them in the parentheses immediately following a subroutine call. The parameters go on the stack starting with the right-hand parameter first, then proceeding in order to the left. The calling routine is responsible for removing parameters from the stack after the called routine returns. Consider this C program fragment:

```
int x, y, z, r;
char c;
...
r = demo(c, x, y, &z);
...
```

This fragment calls a routine named "demo()"; the fragment passes demo() a number of items: character c, integers x and y, and a pointer to integer z (as indicated by the prefix "&").

For this C statement, the compiler generates machine code that pushes the parameters onto the stack, starting with the pointer and ending with c. Then it calls the demo() routine, removes the parameters from the stack after demo() returns, and stores the data that demo() returns at the address of r. When the demo() routine is called, it finds its parameters on the stack, in the specified order, just above the return address for the calling routine.

When demo() begins to execute, the bytes on the stack are

```
high byte of high word of &z
low byte of high word of &z
high byte of low word of &z
low byte of low word of &z
high byte of y
low byte of y
high byte of x
low byte of x
high byte of c (on the stack,)
low byte of c (but meaningless)
high byte of high word of return address
low byte of high word of return address
high byte of low word of return address
low byte of low word of return address
```

Remember that words are pushed onto the stack high byte first, then low byte; double words are pushed onto the stack high word first, then low word. The stack grows downward in memory, and the stack pointer (SP) always points at the last byte on the stack (which is lowest in memory).

If you compile your C language routines in the small model instead of the large model, only one word of the return address, instead of two, will be on the stack, and only one word of pointer &z will be on the stack. Because the 8086/88 can't push less than a word onto the stack, character c—which is only a byte—will reside only in the low byte of the word devoted to it on the stack.

The following C program fragment provides an example of compatible assembly-language and C routines:

```
int least, x, y, sum;
...
least = find_least(x, y, &sum);
...
```

Imagine that find_least() is a C routine that will return the lesser of two integers, x and y, and store the sum of x and y at the address of the integer "sum." The assembly-language fragment in **Fig 2** can call find_least().

The assembly-language code in **Fig 2** follows C compiler rules. The code passes parameters by pushing them—right to left—onto the stack. It then calls find_least(), removes the parameters from the stack, and stores the integer returned by find_least(). **Fig 2**'s routine assumes that the compiler returns short integers in register AX.

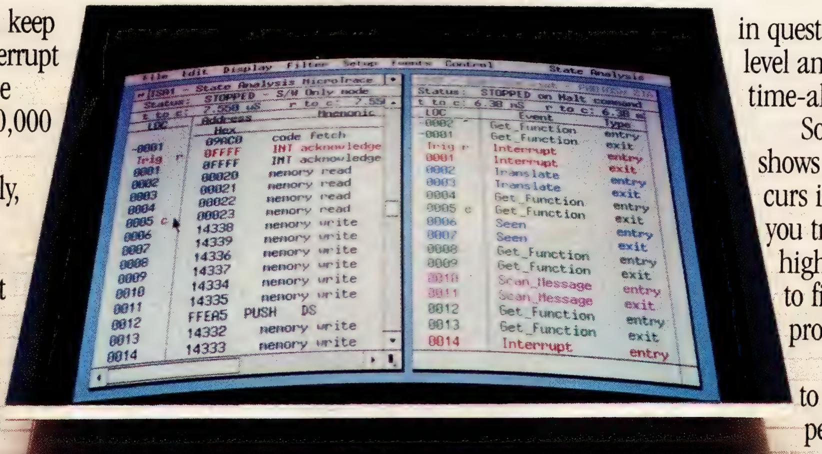
Finally, suppose that after writing find_least() in C, you determine that this high-level-language routine is too slow, and you therefore decide to rewrite it in assembly language. **Fig 3** is an example of the find_least() routine written in assembly language. You can call this assembly-language version of find_least() from either a C routine or an assembly-language routine because it, too, follows the C compiler's conventions for register use and parameter passing. **EDN**

Author's biography

William C Warner is a self-employed consultant in Ann Arbor, MI. He specializes in the application of computers to instrumentation and automation. Will, who has worked for General Electric and Machine Vision International, has a BS in mathematics from Michigan State University.

Article Interest Quotient (Circle One)
High 473 Medium 474 Low 475

Spot a real-time problem that's 100,000 instructions old.



```
File  Edit  Display  Filter  Setup  Events  Control
#ISR1 - State Analysis MicroTrace
Status:  STOPPED - S/W Only mode
t to c:  7.550 uS      r to c:  7.55
  LOC        Address        Mnemonic
               Hex
             09AC0      code fetch
-0001        0FFFF      INT acknowledge
Trig    r    0FFFF      INT acknowledge
0001         00020      memory read
0002         00021      memory read
0003         00022      memory read
0004         00023      memory read
0005    c    14338      memory write
0006         14339      memory write
0007         14336      memory write
0008         14337      memory write
0009         14334      memory write
0010         14335      memory write
0011         FFEA5   PUSH   DS
0012         14332      memory write
0013         14333      memory write
0014
```

```
                                   State Analysis
Status:  STOPPED on Halt command
t to c: 6.38 nS     r to c: 6.38 nS
 LOC           Event               Type
-0002          Get_Function
-0001          Get_Function        entry
Trig    r      Interrupt           exit
0001           Interrupt           entry
0002           Translate           exit
0003           Translate           entry
0004           Get_Function        exit
0005    c      Get_Function        entry
0006           Seen                exit
0007           Seen                entry
0008           Get_Function        exit
0009           Get_Function        entry
0010           Scan_Message        exit
0011           Scan_Message        entry
0012           Get_Function        exit
0013           Get_Function        entry
0014           Interrupt           exit
                                   entry
```

It happens all too often. You keep experiencing a real-time interrupt service problem whose source may have occurred up to 100,000 instructions ago.

But where? Unfortunately, most real-time trace instruments let you go back just a few thousand instructions, at most. Usually not enough to uncover the problem.

Finally, there's a simple way to trace the answer: The Software Analysis Workstation™ (SAW) from NWIS.

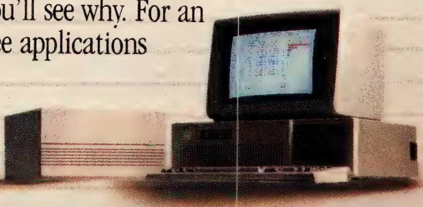
One of the SAW's many features is Context Trace.™ It allows a real-time trace of high-level events, such as procedure entries and exits, line numbers, global variables or any other symbolic events. This selective event capture allows you to trace very large execution windows. In most cases, you can see a high-level trace that is the equivalent of more than 100,000 assembly instructions.

Once this high-level symbolic trace encounters the event associated with the onset of the problem, it triggers a state analyzer which then displays an assembly-level trace of the code in question. Better yet, the high-level and assembly-level traces are time-aligned.

So Context Trace not only shows you how the problem occurs in real-time, but also lets you trace back through as much high-level execution as needed to find the origin of the problem.

And the SAW isn't limited to Context Trace. You also get performance analysis, code coverage analysis and multi-processor trace. All these tools are compiler/assembler and host development computer independent.

The SAW is already producing dramatic results for software engineers around the world. Let us connect the SAW to your target system and you'll see why. For an on-site demo and free applications library, phone:
1-800-547-4445



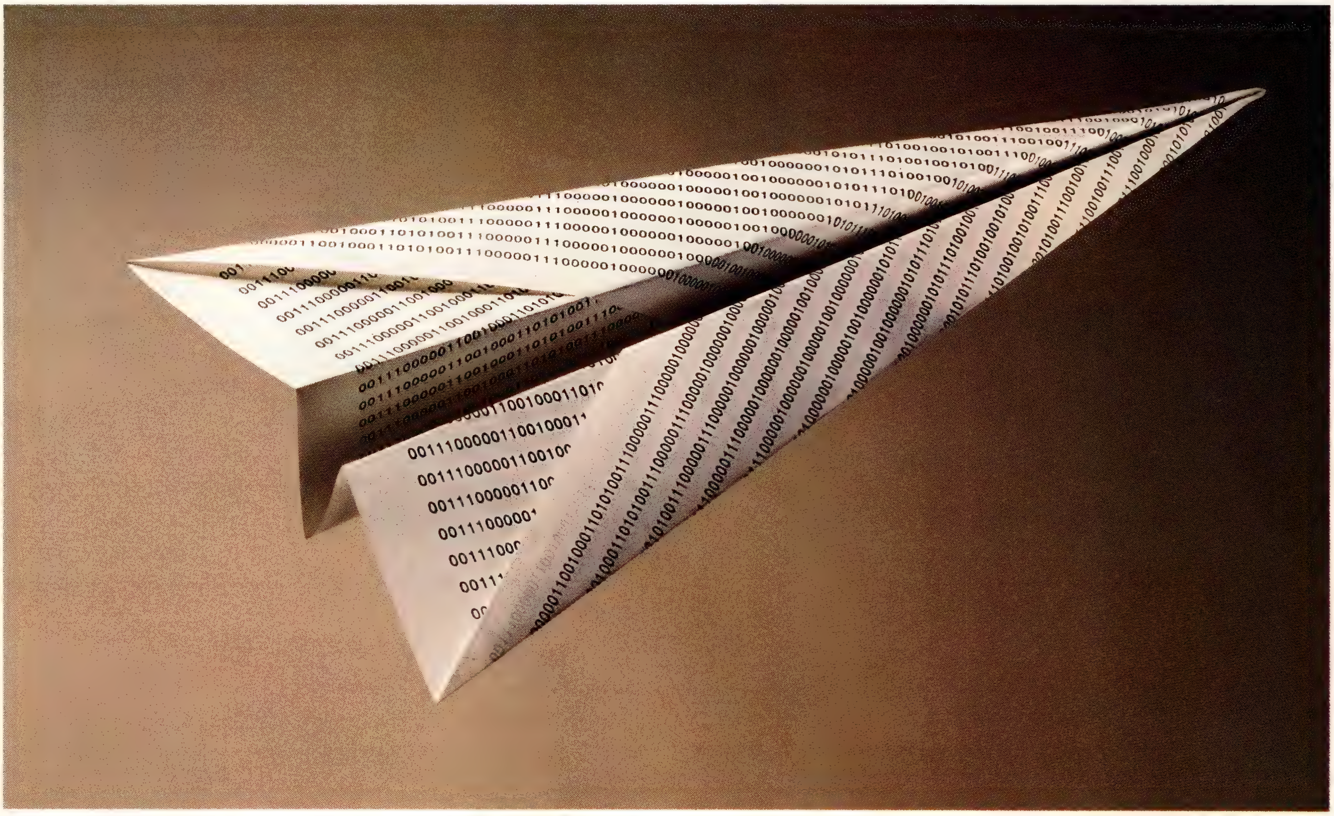
NWIS
NORTHWEST INSTRUMENT SYSTEMS, INC.
P.O. Box 1309 • Beaverton, OR 97075 • 1-800-547-4445

Circle 43 for Literature

Circle 82 for Demonstration

AUSTRIA: 0222-2536260 **BELGIUM:** 02-2418130 **DENMARK:** 0561-1100 **FINLAND:** 0528-4312 **FRANCE:** 01-45347535 or 01-69077878 **ISRAEL:** 03-403373 **ITALY:** 02-4229479 **THE NETHERLANDS:** 01720-43221 **NORWAY:** 02-789460 **SPAIN:** 01-4558112 **SWEDEN:** 08-7390045 **SWITZERLAND:** 01-7231410 **UNITED KINGDOM:** 06284-4426 **NWIS-USA:** 503-690-1300 **WEST GERMANY:** 089-858020

THERE ARE CHEAPER WAYS TO MOVE DATA THAN WITH INTEL'S 588.



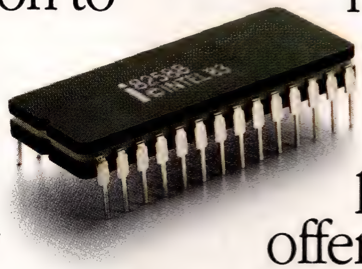
Now you can cut the cost of a PC LAN dramatically with our new 82588 LAN controller.

It's the most integrated networking solution in the 1-2 Mbps range.

And it's optimized to run with standard phone wiring.

Which means that low-cost PC LANs can finally get off the ground. And that's exciting. Especially when you consider that 10 million PCs out there could use an inexpensive way to connect.

That's a great reason to start designing now with the 82588. It's the LAN controller that reduces cost by cutting your board space in half. Saving you the bucks and bother of installing extra chips.



We put timing recovery, data encoding/decoding, collision detection and transmit clock generation all on a single chip. To lower your component count.

Which adds up to even more savings in areas like assembly, testing and reliability.

And we made sure that the 82588 supports emerging LAN standards like StarLAN. It also supports the IBM® PC Network. Plus many other specialized baseband and broadband LANs.

And because it snaps together with Intel's world standard 186 and 188 microprocessors, you eliminate TTL glue and save even more money. While speeding up your design.

To help your LAN products take off, we're offering an easy-to-use design kit. Included are two 82588s plus all the essential hardware, software and documentation needed to tie two PCs together. And all for just $65.

For information on how to get your kit, call Intel toll-free at (800) 548-4725 and ask for Lit. Dept. W-334.

Then see how high your profits can soar.

intel®

© 1986 Intel Corporation
IBM is a registered trademark of International Business Machines Corporation.

THEY STILL MAKE THEM LIKE THEY USE TO...
WE DON'T
THANK GOODNESS.

NO MORE BLOWN FUSES!

Our new Polymer Fuse guards against over-current conditions by switching from low resistance to high resistance when its rated current is exceeded.

Self-Restoring
Returns to low resistance after problem is corrected. Will not reset unless voltage is removed. Will not cause a false reset like bi-metal circuit breakers.

Fool Proof
Polymer is normally mounted on the printed circuit board and cannot readily be replaced with a higher rating or circumvented like cartridge type fuses.

Cost
When compared with the price of a fuse, holder, and assembly time, the Polymer cuts cost for every application. Its small size takes up less space on the board and eliminates nuisance "fuse replacement service calls" because of its self-restoring nature.

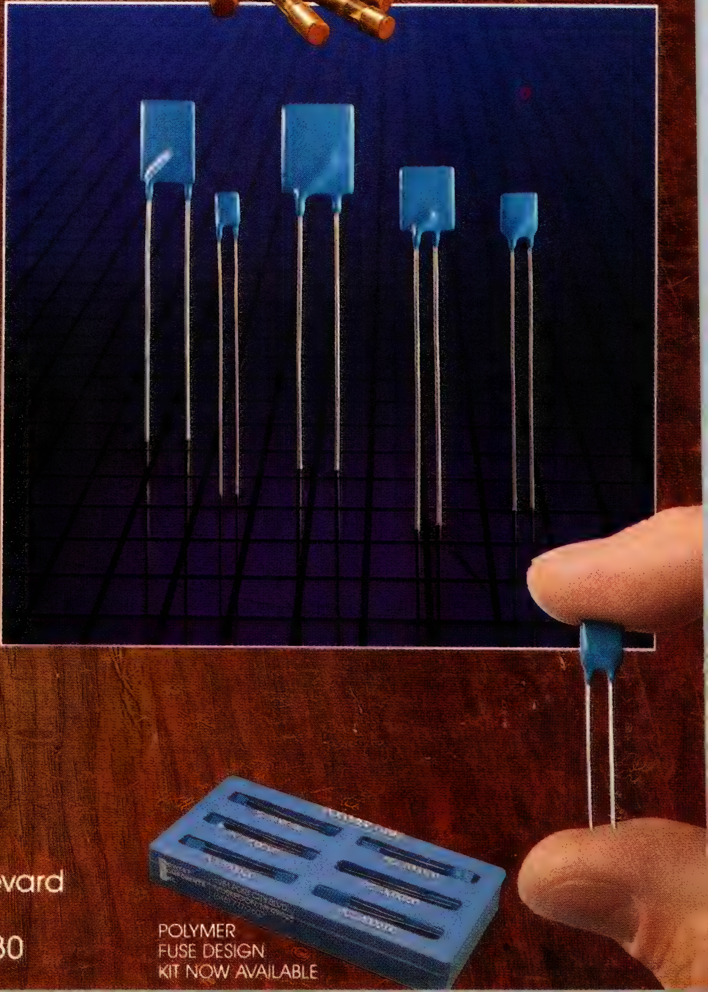
Polymer Fuses are ideal protectors in applications of 40 volts or less. Applications include motors, solenoids, speakers, alarm systems, battery chargers, and communication lines—anywhere older technologies are used now.

CIRCLE NO 90

Phone or write for your free literature package today!

MIDWEST
COMPONENTS
INC.

P.O. Box 787/1981 Port City Boulevard
Muskegon, MI 49443
(616) 777-2602/TWX: 510-394-4130
FAX (616) 773-4307



POLYMER
FUSE DESIGN
KIT NOW AVAILABLE

EDITED BY TARLTON FLEMING

VME system controller reduces parts count

Wade D Peterson
Mizar Inc, St Paul, MN

The VME Bus system controller (**Fig 1**) provides three essential functions: a reset circuit, a 16-MHz system clock driver, and a bus arbiter. Some systems will need additional functions, but this circuit minimizes pc-board area and cost.

The timing components R_1 and C_1 help generate a minimum 300-msec pulse ($\overline{\text{SYSRESET}}$). (The Schmitt-trigger input of IC_{1A} sources current, lowering the effective time constant.) The open-collector driver IC_2 issues this pulse following power-up or following a manual reset command, which you enter by pulsing the momentary-on switch S_1. IC_2 can sink 48 mA as required by the VME Bus specification. Resistor R_2 protects the switch and capacitor by limiting the discharge current to about 1A pk, and the Schottky diode (D_1) provides a capacitor-discharge path when you turn the power off and then back on again.

The TTL oscillator IC_3 offers adequate stability for the system clock (SYSCLK) because the 16-MHz signal has no relation to other signals on the bus. SYSCLK requires a 64-mA drive capability such as that provided by the totem-pole output of IC_4.

The system controller must provide an efficient method of bus arbitration to support the VME Bus's capability for multiprocessing. NAND gates IC_{5A} and IC_{5B} implement a single-level arbiter that can accommodate as many as 21 processors. When a bus master (CPU module) requests use of the bus (by asserting $\overline{\text{BR3}}$), the arbiter circuit asserts the bus-grant signal $\overline{\text{BG3IN}}$. This signal follows a daisy-chain path down the VME Bus backplane until it reaches the requesting module, which then asserts the bus-busy signal ($\overline{\text{BBSY}}$) until its transfers are complete.

The VME Bus specification requires that the system controller reside in slot 1, but the controller may operate as a subsystem in other slots as well. Accordingly, the enable/disable switch S_1 must be closed for operation in slot 1 and open for operation in the other slots.

EDN

To Vote For This Design, Circle No 750

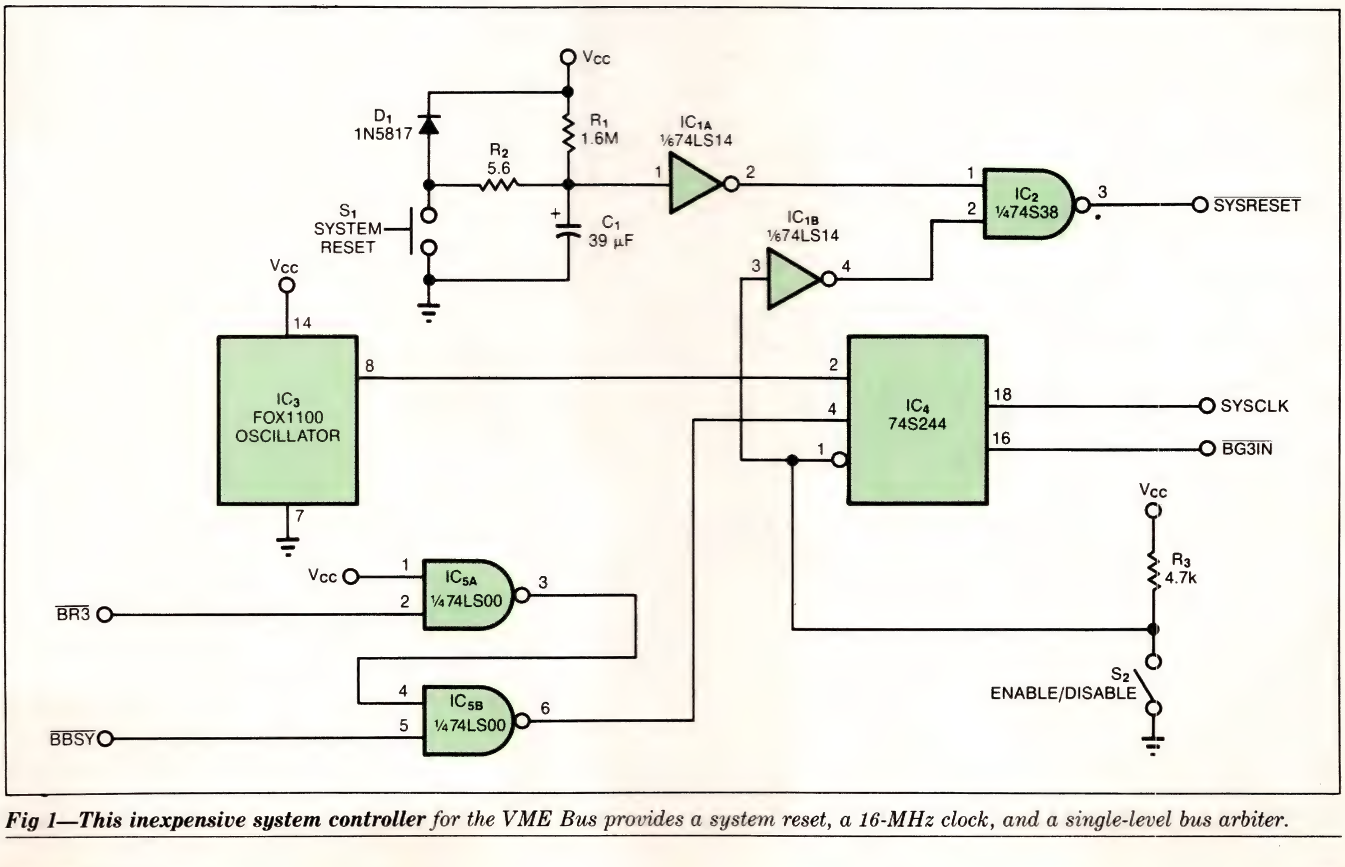


***Fig 1—This inexpensive system controller** for the VME Bus provides a system reset, a 16-MHz clock, and a single-level bus arbiter.*

Circuit vocalizes hex code for 4-bit input

Ricardo G Jiménez
Mexicali Technological Institute, Calexico, CA

The **Fig 1** circuit is a general-purpose annunciator that interprets a 4-bit binary input code ABCD and vocalizes the corresponding hexadecimal word. The speaker gives an audible report each time you press the S_1 switch.

The contents of the EPROM (IC_4) drive a speech processor (IC_5), whose pulse-code-modulated output (pin 24) undergoes filtering and amplification before driving the speaker. By addressing the processor's 59

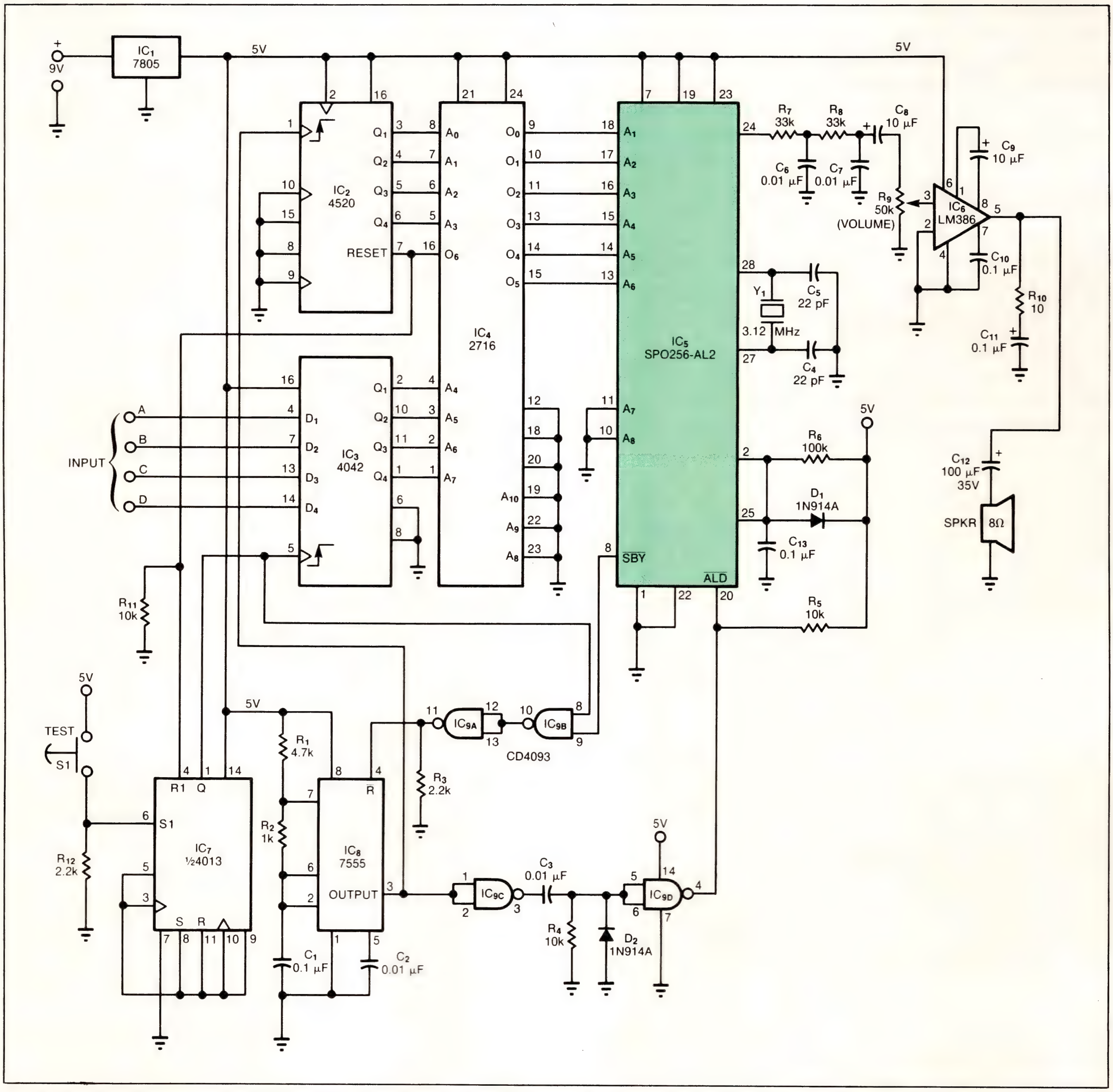


***Fig 1—This circuit's speech processor (IC_5)** synthesizes audible words for hexadecimal codes corresponding to the binary input on lines A, B, C, and D.*

from **99¢**

dc to 2000 MHz amplifier series

SPECIFICATIONS

Model	Frequency MHz	Gain, dB (min.)	Max. Power dBm (typ)	NF dB (typ)	Price $	
					Ea.	Qty.
MAR-1	DC-1000	13	0	5.0	0.99	(100)
MAR-2	DC-2000	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	8	+8	6.0	1.70	(25)
MAR-4	DC-1000	7	+11	7.0	1.90	(25)
MAR-7	DC-2000	8.5	+4	5.0	1.90	(25)
MAR-8	DC-1000	21	+10	3.5	2.20	(25)

Unbelievable, until now...tiny monolithic wideband amplifiers for as low as 99 cents. These rugged 0.085 in.diam.plastic-packaged units are 50ohm input/output impedance, unconditionally stable regardless of load*, and easily cascadable. Models in the MAR-series offer from 7 to 21dB gain, 0 to +11dBm output, noise figure as low as 3.5dB (5.5dB typical), and up to DC-2000MHz bandwidth.

**3:1 load VSWR for the MAR-8*

Also, for your design convenience, Mini-Circuits offers chip coupling capacitors at 12 cents each*

Size (mils)	Tolerance	Temperature Characteristic	Value
80 × 50	5%	NPO	10, 22, 47, 68, 100, 470, 680, 1000 pf
80 × 50	10%	X7R	2200, 4700, 6800, 10,000 pf
120 × 60	10%	X7R	.022, .047, .068, .1μf

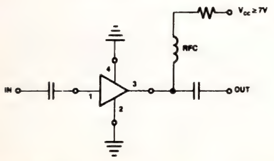
* MINIMUM ORDER 50 PER VALUE

designers amplifier kit, DAK-1

5 of each model, total 30 amplifiers

only $49.99

Typical Biasing Configuration



finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

C113 REV. B

CIRCLE NO 91

allophones and five pauses in the proper sequence, you can synthesize the required hexadecimal word: one of the numbers "zero" through "nine," or one of the letters "A" through "F" **(Listing 1).**

Flip-flop IC$_7$'s Q output latches high when you press S$_1$, causing IC$_3$ to latch the input data and apply it to the EPROM's upper address inputs A$_4$-A$_7$. This action selects a block of memory within the EPROM; counter IC$_2$ then scans those memory locations in sequence by driving the lower address bits A$_0$-A$_3$. As a result, the EPROM delivers a preprogrammed sequence of instructions to the speech processor.

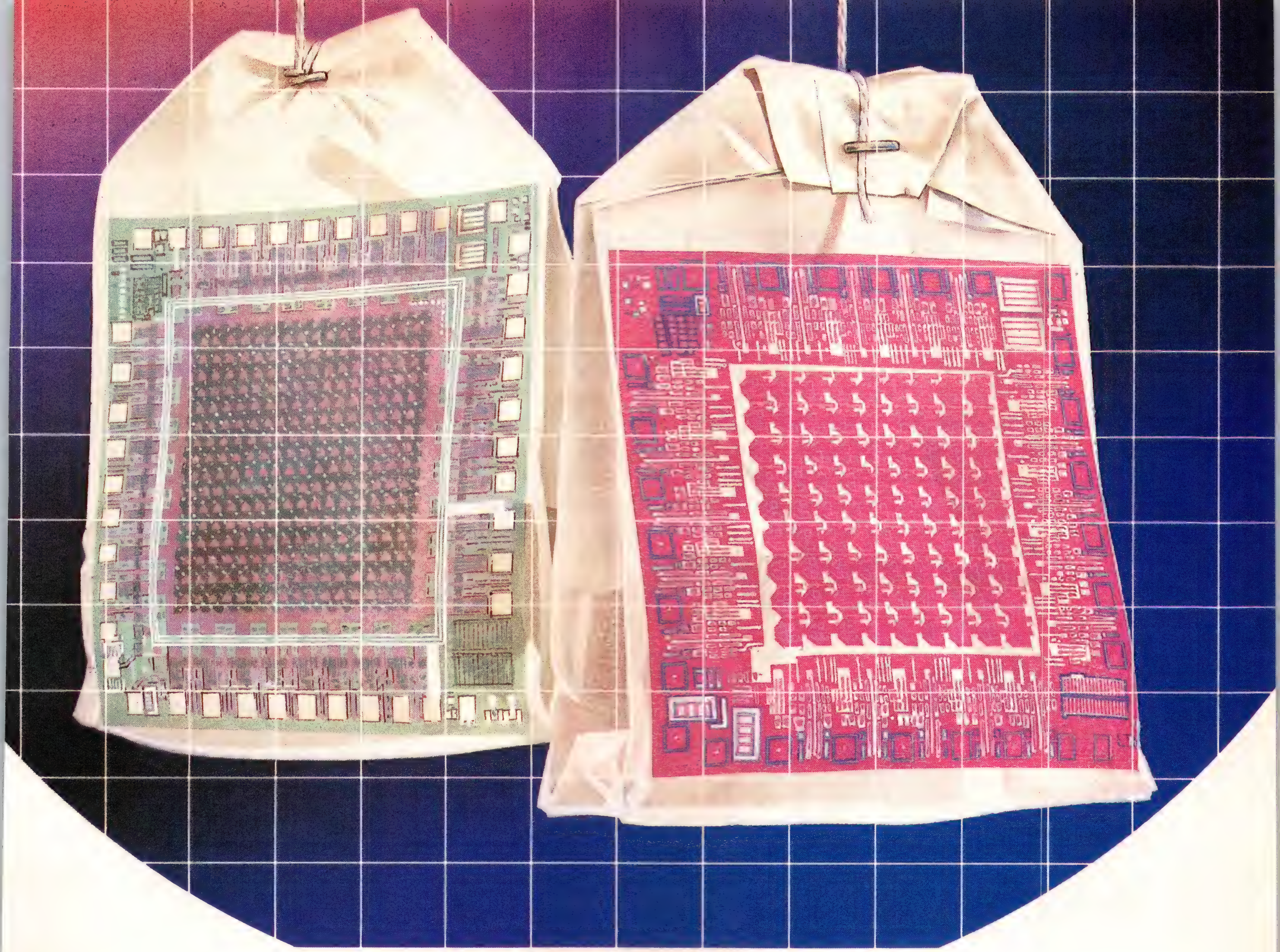
Timer IC$_8$ and associated components form an astable, 2150-Hz oscillator that operates in 1-Hz bursts. Each positive transition at the timer's output (pin 3) advances counter IC$_2$ by one (starting with zero, following the closure of S$_1$). Each negative transition at pin 3 causes IC$_{9C}$ and IC$_{9D}$ to generate a negative pulse at the speech processor's address-load input ($\overline{\text{ALD}}$), which loads the current EPROM output and causes the processor to assert a low logic level at $\overline{\text{SBY}}$ (pin 8). This action resets the timer output to zero.

The processor chip holds $\overline{\text{SBY}}$ low for an interval appropriate to that particular allophone; when $\overline{\text{SBY}}$ returns high, the timer initiates the next allophone cycle. Each audible report requires one to seven allophones as shown in **Listing 1.** Following each report, the hex-data instructions 4 and 44 reset the speech processor (internally) and the corresponding counter and flip-flop (via output O$_6$). For the input ABCD=1010 (decimal 10), for example, the speaker will say the hexadecimal equivalent, "A." **EDN**

To Vote For This Design, Circle No 747

LISTING 1—EPROM CONTENTS

DECIMAL ADDRESS	HEX ADDRESS	HEX DATA	
0	0	4	
1	1	2B	
2	2	3C	"ZERO"
3	3	35	
4	4	4	
5	5	44	
16	10	39	
17	11	F	
18	12	F	"ONE"
19	13	B	
20	14	4	
21	15	44	
32	20	D	
33	21	1F	"TWO"
34	22	4	
35	23	44	
48	30	1D	
49	31	E	"THREE"
50	32	13	
51	33	4	
52	34	44	
64	40	28	
65	41	28	"FOUR"
66	42	3A	
67	43	4	
68	44	44	
80	50	28	
81	51	28	"FIVE"
82	52	6	
83	53	23	
84	54	4	
85	55	44	
96	60	37	
97	61	37	"SIX"
98	62	C	
99	63	C	
100	64	2	
101	65	29	
102	66	37	
103	67	4	
104	68	44	
112	70	37	
113	71	37	"SEVEN"
114	72	7	
115	73	7	
116	74	23	
117	75	C	
118	76	B	
119	77	4	
120	78	44	
128	80	14	
129	81	C	"EIGHT"
130	82	D	
131	83	4	
132	84	44	
144	90	38	
145	91	18	"NINE"
146	92	6	
147	93	B	
148	94	4	
149	95	44	"A"
160	A0	14	
161	A1	4	
162	A2	44	
176	B0	3F	"B"
177	B1	17	
178	B2	4	
179	B3	44	
192	C0	37	
193	C1	37	"C"
194	C2	17	
195	C3	4	
196	C4	44	
208	D0	21	
209	D1	17	"D"
210	D2	4	
211	D3	44	
224	E0	17	"E"
225	E1	4	
226	E2	44	
240	F0	7	
241	F1	7	"F"
242	F2	28	
243	F3	28	
244	F4	4	(RESETS IC$_5$)
245	F5	44	(RESETS IC$_2$ AND IC$_7$)



P.G. tips.

Ferranti announces two new blends of ULA* with the 'P' series and the 'G' series.

Both offer a subtle mixture of digital and linear in the same brew. Each Digilin* ULA satisfies the different flavours of system design.

The 'P' series puts the emphasis on digital but with just the right amount of linear ingredient for complete system integration.

The 'G' series is for those systems requiring high performance linear but shared with equal amounts of digital.

Both provide the opportunity of improving system economics, performance and design security by integrating much more of your system than perhaps was thought possible.

As well as combined digital and linear performance, they operate from virtually any supply including single cell battery operation. They provide high current drive capability up to 250mA and complete design software, including SPICE available on the IBM PC/AT.

Take a tip from the 'P' series and the 'G' series for your chip requirements.

IC Marketing
Ferranti Electronics Limited
Fields New Road Chadderton
Oldham OL9 8NP England
Telephone: 061-624 0515 Telex: 668038
Fax: 061-626 4946

BETTER
BY
DESIGN

FERRANTI
Semiconductors

*ULA and Digilin are registered Trade Marks of Ferranti plc for semiconductor devices.

CIRCLE NO 81

International Addresses:
☐ Ferranti GmbH, West Germany, Munich, Tel: (089)-3609-06-0 ☐ Ferranti Electronics Benelux, Antwerp, Tel: (0)-3/542.62.73
☐ Ferranti Electronics Sweden, Stockholm, Tel: (08)-52 07 20 ☐ Ferranti Computer Systems (Australia) Pty Limited, Revesby, Tel: (02)-708 6655
☐ Ferranti Wheelock Microelectronics, Aberdeen, Hong Kong, Tel: (5)-538298-9 ☐ Ferranti Interdesign Inc. USA, California, Tel: (408)-438-2900.

Video IC extracts timing waveforms

Martin Giles
National Semiconductor Corp, Santa Clara, CA

To combine two video sources in one CRT display (such as a VCR signal and a computer-generated graphics overlay), you must first synchronize their timing waveforms. **Fig 1**'s circuit accomplishes this task by extracting timing information from one source for use in the other. You provide only a composite-video input to the circuit.

Most of the work is then done by the video-sync separator IC_1, which restores dc to the video at pin 2, separates the composite-sync signal and provides this output at pin 1, and provides a vertical-sync signal at pin 3 that's precisely synchronized with the vertical interval's first serration. IC_1 provides a field index pulse at pin 7 (for interlaced video sources) that's high during the even field (1) and low during the odd field (2).

To extract the color-subcarrier signal, IC_1 issues a

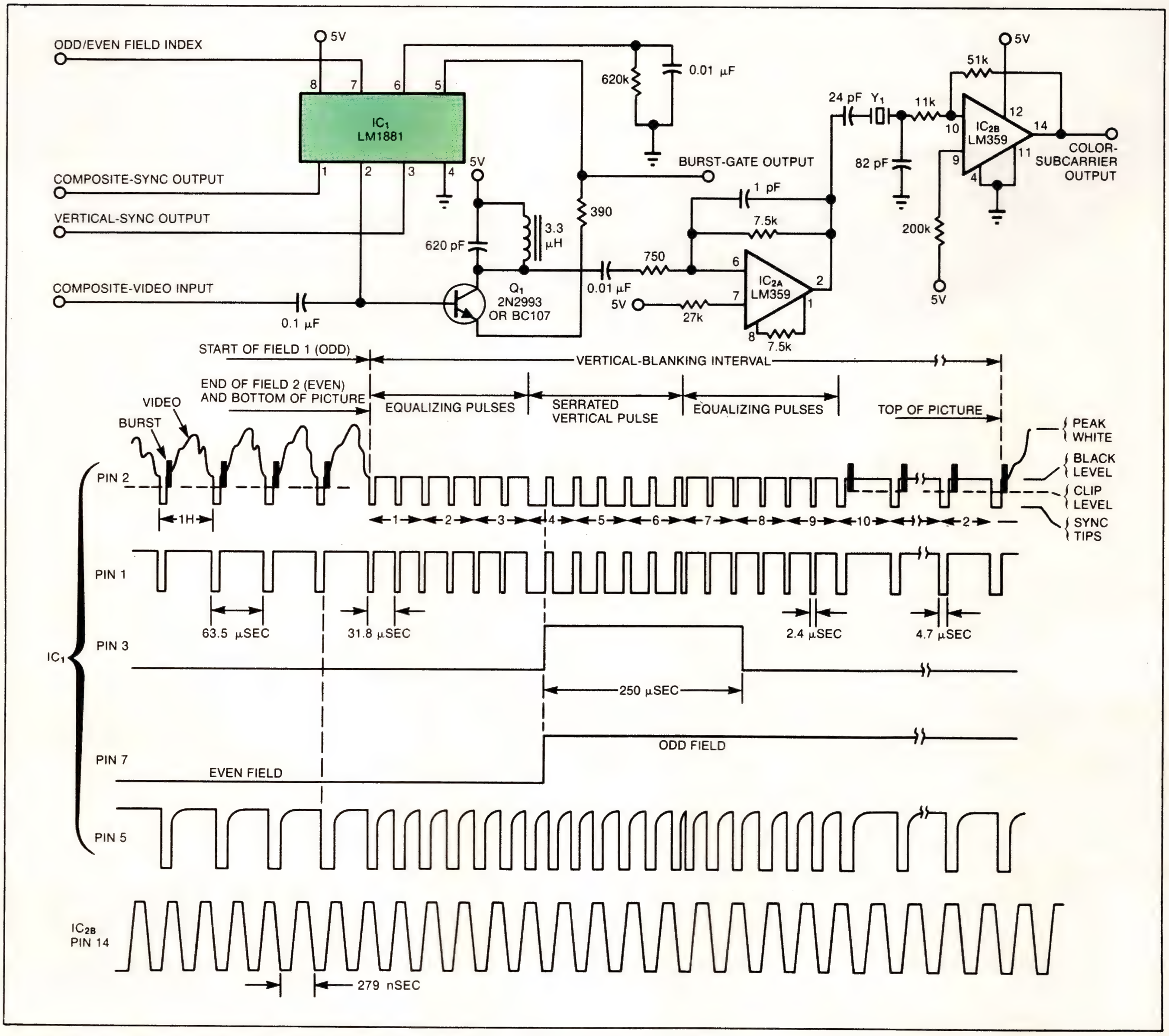


***Fig 1—This circuit strips the timing information** from a composite-video signal for use in synchronizing the signal with another video source.*

75X Family

4-Bit Micros with 8-Bit Power

The µCOM-75X is for people who enjoy getting more than they bargained for. As a 4-bit single-chip machine, it offers true 8-bit processing power. Memory capacity on-chip is 16 Kbyte ROM and 512 nibble RAM. Instruction cycle time is under 1 µs when clocked at 4.19 MHZ crystal. Register architecture is enhanced by a powerful instruction set supporting 1/4/8-bit manipulation and flexible use of memory space. All family members come in very low power consumption CMOS technology.

The members of the µCOM-75X family all have dedicated on-chip function blocks for different control environments. The highend versions for instance, have 58 general I/O lines, 3 timers and a comparator port.

µCOM 75X Family
- µCOM 75X High End
- µCOM 75X LCD
- µCOM 75X General Purpose with FIP

West Germany: Düsseldorf 02 11/65 03 01, Telex 8 58 996-0
The Netherlands: Eindhoven 0 40/44 58 45, Telex 51 923
France: Paris 01/39 46 96 17, Télex 699 499
Italy: Milano 02/67 09 108, Telex 315 355
Sweden: Täby 08/73 28 200, Telex 13 839
UK: Milton Keynes 09 08/69 11 33, Telex 777 565

NEC

CIRCLE NO 54

burst-gate output (pin 5) that turns on the transistor amplifier, Q_1, only during the composite waveform's color-burst interval. Op amp IC_{2A} amplifies the frequency burst and applies it to the 3.579545-MHz crystal Y_1. Because the input resistance of op amp IC_{2B} sets a high Q for the crystal circuit (approximately 10k), the crystal continues to ring between bursts, providing a constant color-subcarrier output. **EDN**

To Vote For This Design, Circle No 748

Nested functions transform filter roots

David C Bidwell
Dowty-RFL Industries Inc, Boonton, NJ

The nested-function routine of **Fig 1a** transforms the roots of a lowpass transfer function to the roots of an equivalent bandpass transfer function. By including the routine in a filter program that solves for the roots of lowpass functions (for example, Butterworth, Chebyshev, and elliptical), you can obtain the equivalent bandpass roots for any desired Q. The usefulness of nested, user-defined functions for Basic programming has been discussed before (**Ref 1**).

Written in Microsoft Basic for the IBM PC, the routine of **Fig 1a** exhibits the following characteristics:

- It uses no transcendental functions except the square root; this approach is simpler than the polar form based on trigonometric functions described in **Ref 2**.
- It uses no approximations, but instead solves the exact formulas given in **Ref 3**.
- It is highly accurate in single-precision arithmetic for any practical filter-circuit Q (QC), defined as $\sqrt{(f_1 f_2)}/(f_2-f_1)$, where f_1 and f_2 are the filter's lower and upper 3-dB frequencies, respectively.
- It converges on the simple linear transformation discussed in **Ref 3** for high QC.

EDN

```
PROGRAM BPFUNC (USER FUNCTIONS FOR BPXFRM)

10 INPUT "QC = ";Q
20 DEF FNT(A,B) = (B*B - A*A)/2/Q ^2 + 2
30 DEF FNV(A,B) = SQR(FNT(A,B) + SQR(FNT(A,B)^2 + A*A*B*B/Q ^4))
40 DEF FNU(A,B) = A*B/Q^2/FNV(A,B)
50 DEF FNR(A,B) = (A/Q + FNU(A,B))/2
60 DEF FNI(A,B) = (FNV(A,B) + B/Q)/2
70 DEF FNA(A,B) = (A/Q - FNU(A,B))/2
80 DEF FNB(A,B) = (FNV(A,B) - B/Q)/2
90 INPUT "ALPHA, BETA";A,B
100 PRINT USING "###.######  +/-J ###.######";FNR(A,B),FNI(A,B)
110 PRINT USING "###.######  +/-J ###.######";FNA(A,B),FNB(A,B)
120 PRINT
130 GOTO 90
```

(a)

```
RUN
QC =? 1
ALPHA, BETA? 0,2.6003
   0.000000   +/-J  2.940391
   0.000000   +/-J  0.340091

ALPHA, BETA? .48307,0
   0.241535   +/-J  0.970392
   0.241535   +/-J  0.970392

ALPHA, BETA?
Break in 90
Ok
RUN
QC =? 25
ALPHA, BETA? .2,.8
   0.004064   +/-J  1.016120
   0.003936   +/-J  0.984120

ALPHA, BETA? .7071067,.7071067
   0.014342   +/-J  1.014142
   0.013942   +/-J  0.985858

ALPHA, BETA?
Break in 90
Ok
```

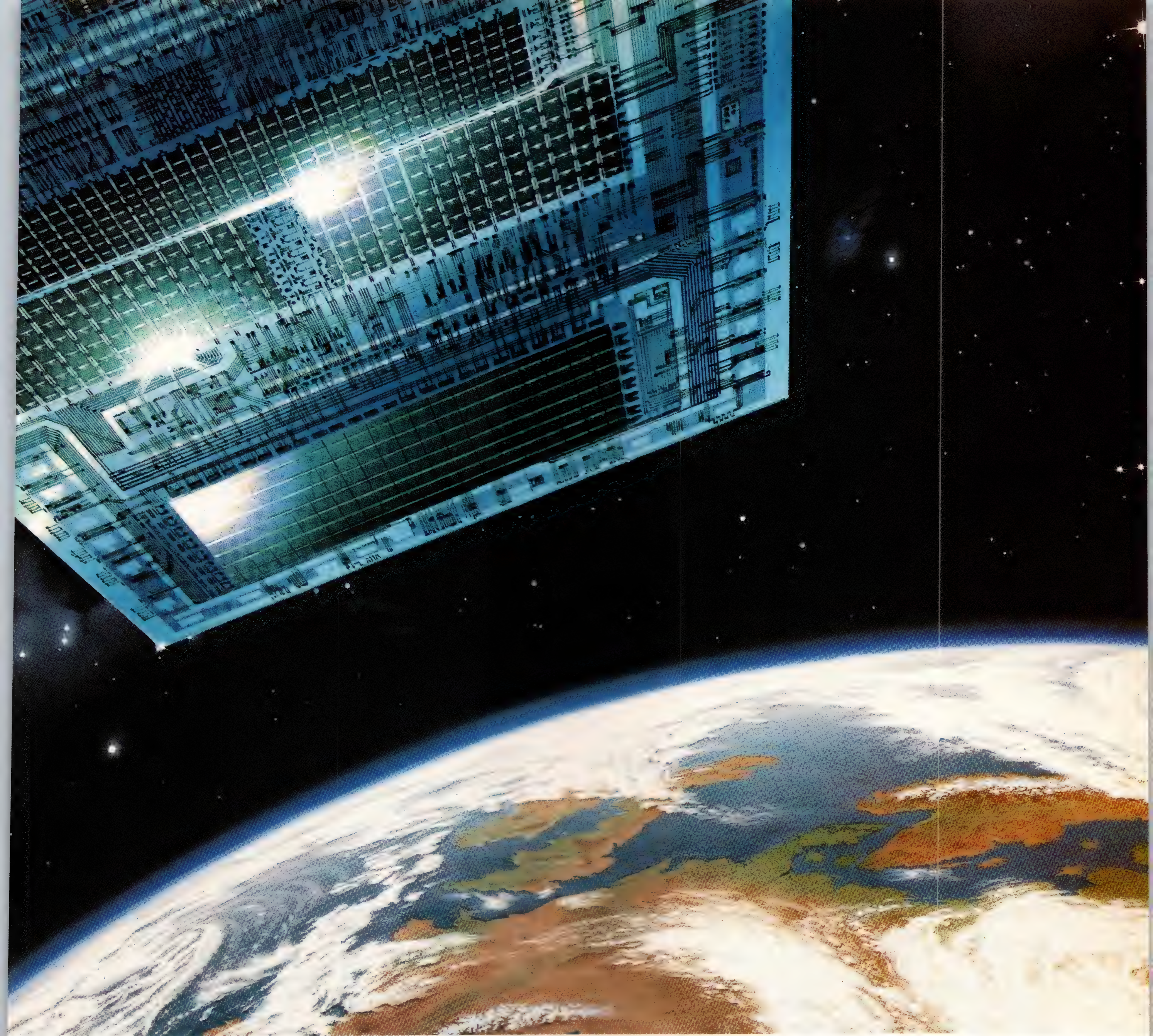
(b)

Fig 1—This routine of nested functions (a), *when embedded in a lowpass-filter program, calculates roots for the equivalent bandpass function. (QC is the desired filter Q; alpha and beta are the real and imaginary parts of the lowpass root.) Examples of the routine's output are shown in* ***b.***

References

1. Bidwell, D, "Nested functions calculate standard Rs," *EDN*, June 28, 1984, pg 275.
2. Delagrange, A, and Douyon, R, "Pocket calculator eases filter design," *EDN*, January 24, 1985, pg 243.
3. Bidwell, D, "Filter transforms beat approximations," *EDN*, August 5, 1981, pg 141.
4. Knaell, K, "Lowpass/bandpass transform beats computers," *EDN*, March 4, 1981, pg 152.

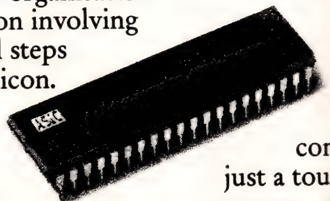
To Vote For This Design, Circle No 746



The new force in ASICs

A unique force! Bringing ASIC technology to the service of European systems houses.

Application-Specific ICs offer systems houses cost and reliability gains. But most houses lack either design expertise or the organisation for a back-end operation involving hundreds of individual steps between design and silicon.



Which is where ASiC - Advanced Silicon Corporation - comes in. A full- service company, ASiC has all the know-how and ability to put your systems onto silicon. Giving you economy and speed. From spec to silicon - and beyond!

With both in-house and contracted facilities, ASiC offers processes in CMOS and NMOS, single and double-layer metal, with geometries from 3 microns downward. Our advanced silicon compilation software needs just a touch of a key to change processes. Adapting your systems to advancing VLSI technology. Right into the next century.

The unique force in ASICs isASiC, headquartered in The Netherlands with offices in London, Paris and Munich.

Advanced Silicon Corporation (ASiC)
Villa "Waalheuvel" Rijksstraatweg 24
6574 AD Ubbergen
The Netherlands
Tel: 31(0)80 228212
Telex: 48592 asic nl
Telefax: 31(0)80 241585

GIGANTIC IN MICRO

Advanced Silicon Corporation

CIRCLE NO 53

Design Entry Blank

$75 Cash Award for all entries selected by editors. An additional $100 Cash Award for winning design each issue, determined by vote of readers. Additional $1500 Cash Award for annual Grand Prize Design, selected among biweekly winners by vote of editors.

To: Design Ideas Editor
EDN
Cahners Publishing Co
275 Washington St, Newton, MA 02158

I hereby submit my entry for EDN's Design Ideas program.

Name ____________

Title ____________ Phone ____________

Company ____________

Division (if any) ____________

Street ____________

City ____________ State ______ Zip ______

Design Title ____________

Home Address ____________

Social Security No ____________

Entry blank must accompany all entries. Design entered must be submitted exclusively to EDN, must be original with author(s), must not have been previously published (limited-distribution house organs excepted), and must have been constructed and tested.

Exclusive publishing rights remain with Cahners Publishing Co unless entry is returned to author or editor gives written permission for publication elsewhere.

In submitting my entry, I agree to abide by the rules of the Design Ideas Program.

Signed ____________

Date ____________

Your vote determines this issue's winner. All designs published win $75 cash. All issue winners receive an additional $100 and become eligible for the annual $1500 Grand Prize.

Vote now, by circling the appropriate number on the reader inquiry card.

Submit your own design, too. Mail entries to Design Ideas Editor, EDN, 275 Washington St, Newton, MA 02158.

Circuit debounces pushbutton switch

Brian A Wittman
AT&T Consumer Products, Indianapolis, IN

Fig 1 is a simple alternative to the traditional debounce circuit based on a flip-flop. The inverters IC_{1A} and IC_{1B} form a bistable latch; closing the switch forces the latch to change and remain in the opposite state.

For most pushbuttons, 50 msec is a reasonable value for the product of R_2C_1. The interval must be short enough to register a rapid sequence of switch closures but long enough to avoid false signals caused by switch bounce. Resistor R_2's value should be at least 10 times that of R_1 to ensure proper operation despite the divider effect of these resistors. By substituting a NAND gate for either inverter and adding a power-on reset circuit at the other input, you can make the latch assume a desired state at power-up. **EDN**

To Vote For This Design, Circle No 749

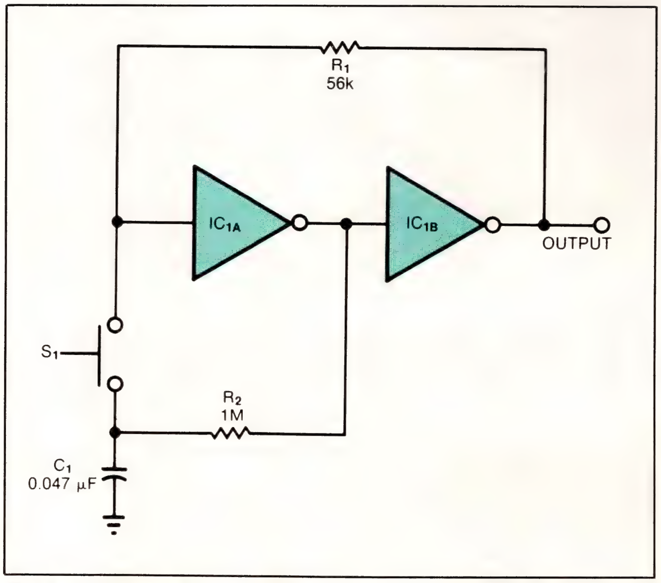


Fig 1—Inverters IC_{1A} and IC_{1B} form a bistable latch that debounces the pushbutton switch S_1.

You'll find outstanding specs, performance, pricing and availability in these new I/O Modules... from Grayhill or your local Grayhill distributor, in all standard configurations. All are compatible with 5, 15 or 24V logic circuits.

AC output	120V or 240V	black case
DC output	3V to 60V	red case
AC input	120V or 240V	yellow case
DC input	3V to 32V	white case

Prove it to yourself... ask us for free literature with complete product specifications and prices.

Grayhill INC

561 Hillgrove Avenue, P.O. Box 10373
LaGrange, Illinois 60525-0373 USA
Phone: (312) 354-1040 TLX: 6871375
TWX: 910-683-1850 FAX: (312) 354-2820

AVAILABLE LOCALLY THROUGH THESE REPRESENTATIVES

AUSTRALIA/NEW GUINEA Acme Engineering
Kilsyth, Victoria • Tel: (03) 890-0900
BELGIUM/LUXEMBOURG Rodelco SA/NV Electronics
Brussels • Tel: 02-2166330
CHINA, REPUBLIC OF Morrihan International
Taipei • Tel: (02) 752-2200
DENMARK E.V. Johanssen Elektronik A-S
Copenhagen • Tel: (01) 83 90 22
FRANCE Radio Television Francaise
Gentilly • Tel: (011) (33) (14) 664-1101
FINLAND OY Flinkenberg & Co., AB
Helsinki • Tel: (90) 647-311
GERMANY Data Modul GmbH
München • Tel: (089) 56 01 70
HONG KONG Components Agent Ltd.
Hong Kong • Tel: (0) 499-2688
INDIA Hindco Corporation
Bombay • Tel: 011-91-22-493-1544
IRELAND, REPUBLIC OF Neltronic Ltd.
Dublin • Tel: (011) (353) (1) 501845
ISRAEL Rapac Electronics, Ltd.
Tel Aviv • Tel: (03) 477115
ITALY Microelit s.r.l.
Milano • Tel: (011) (39) (2) 499-0444
Rome • Tel: (011) (39) (6) 889-4323
JAPAN Jepico Corp.
Tokyo • Tel: (03) 348-0611
NETHERLANDS Rodelco BV Electronics
Breda • Tel: (011) (31) (76) 78-4911
NEW ZEALAND S.D. Mandeno
Auckland • Tel: (09) 600-008
NORWAY Hans H. Schive A/S
Nesbru • Tel: (011) (47) (2) 845160
SINGAPORE, REPUBLIC OF Microtronics Associates Ltd.
Singapore • Tel: 7481835
SOUTH AFRICA, REPUBLIC OF Liberty Electronics Ltd.
Boksburg • Tel: (11) 52-7637
SOUTH KOREA Unistandard Corporation
Seoul • Tel: (82) (2) 532-6815 16
SPAIN Unitronics SA
Madrid • Tel: (01) 242 52 04
SWEDEN Bo Palmblad Aktiebolag
Bromma • Tel: (08) 25 27 20
SWITZERLAND Walter Blum AG
Zurich • Tel: (01) (41)(1) 312 68 72
UNITED KINGDOM Highland Electronics, Ltd.
Burgess Hill, West Sussex • Tel: (44) 4446-45021

CIRCLE NO 93

Design Ideas Winners January through December 1986

January 9, 1986
Brian Koga, Wang Laboratories Inc, Lowell, MA. "68020 adapter upgrades 68000 systems."
January 23, 1986
Irwin Cohen, Hewlett-Packard Co, Rockaway, NJ. "Divider produces symmetrical output."

February 6, 1986
Richard Poindexter, Telex Computer Products, Tulsa, OK. "Use simple circuit to program EPROMs."
February 20, 1986
Edward W Rummel, Robin Baker Associates Inc, Short Hills, NJ. "Generate bipolar logic levels from a 5V supply."

March 6, 1986
Christos S Koukourlis, Demokritos University of Thrace, Xanthi, Greece. "Test probe measures 4 to 220V."
March 20, 1986
Jeffrey Anthony, Corby Industries Inc, Whitehall, PA. "C function calls the IBM PC I/O system."

April 3, 1986
Michael Ellis, Scientific Atlanta, Norcross, GA. "Feedforward amplifier reduces distortion."
April 17, 1986
Robert D Grappel, MIT Lincoln Laboratory, Lexington, MA. "Square-root algorithm is fast and simple."

May 1, 1986
Robert J Zavrel, Signetics Inc, Sunnyvale, CA. "IF chip forms audio decibel-level detector."
May 15, 1986
John A Haase, Colorado State University, Fort Collins, CO. "Digital power controller handles 1 kW."
May 29, 1986
Mark D Braunstein, Contel Information Systems, Fairfax, VA. "Simple circuit tests twisted-pair cables."

June 12, 1986
Joseph G Vazach, Allen-Bradley Co, Highland Heights, OH. "Enlarge Z80 memory space to 512k bytes."
June 26, 1986
Steve Momii, University of Washington, Seattle, WA. "Circuit generates frequency difference."

July 10, 1986
Mark Walczak, Microcontrol Pty Ltd, Monterey, Australia. "Low-power RS-232C driver operates from 5V."

August 7, 1986
Thomas Hack, Master Designers Inc, Colorado Springs, CO. "Program computes log magnitude and phase."
August 21, 1986
H H Eck, Pulse Electronics Inc, Rockville, MD. "Circuit provides controllable resistance."

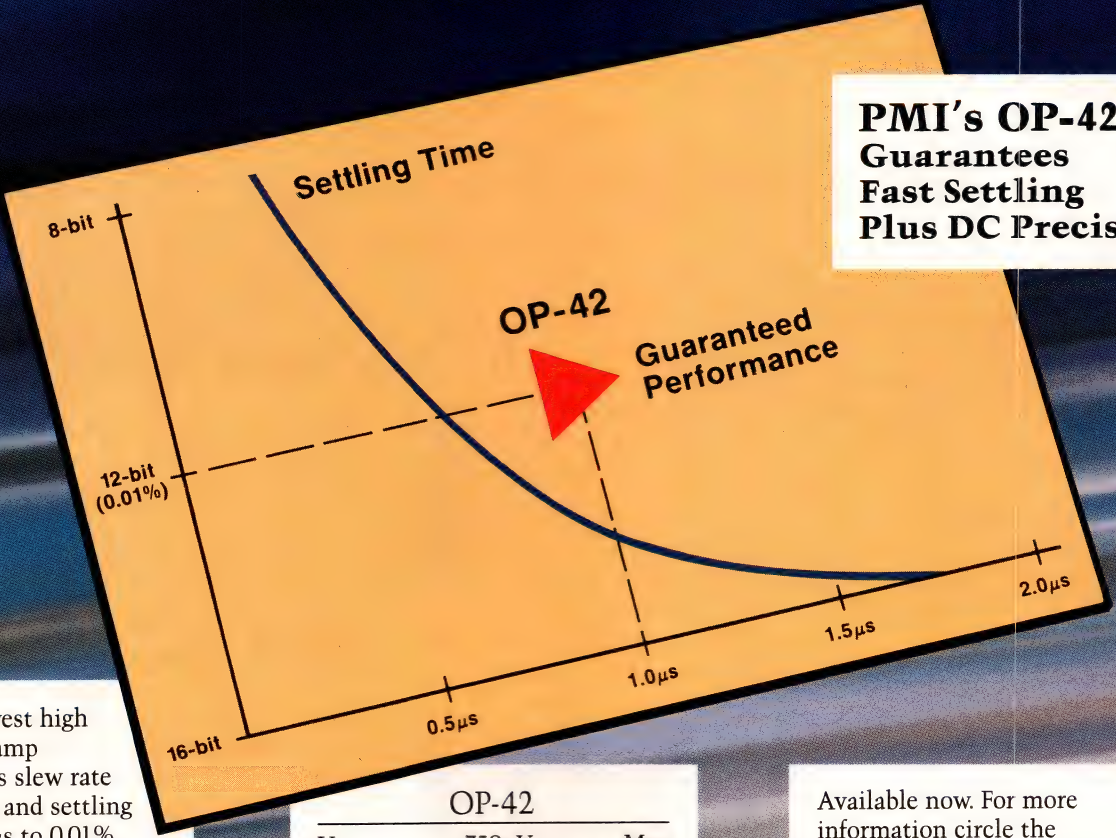
Winning Idea is an adapter for upgrading 68000-based pc boards

Brian Koga has won EDN's $1500 grand prize for the best Design Idea of 1986. His January 9, 1986, entry, "68020 adapter upgrades 68000 systems," lets you enhance an existing 68000 board to take advantage of the 68020's larger instruction set. In some cases, the 68020's higher clock rate lets you speed up program execution as well. To use the adapter, you plug it into a 68000 socket and then plug a 68020 μP into a socket on the adapter board. Logic gates on the board derive the additional signals that the 68020 requires.

Mr Koga developed this adapter to allow software developers to begin debugging 68020 code without waiting for layout and fabrication of a 68020 board. He suggests that others could do the same. In addition, he has used the adapter to enhance the performance of a Commodore Amiga computer.

These activities reflect two of Mr Koga's interests: developing socket adapters and working with personal computers. Another interest is skiing, which he enjoys when time permits. Mr Koga holds a BSEE from Northrop University (Ingleside, CA) and is a principal hardware engineer with Wang Laboratories in Lowell, MA. Before coming to Wang in 1984, he was with IBM in Danbury, CT. Congratulations, Mr Koga, from all of us at EDN. —*Tarlton Fleming*

SPEED WITHOUT COMPROMISE



PMI's OP-42
Guarantees
Fast Settling
Plus DC Precision

PMI's newest high speed op amp guarantees slew rate of 50V/µs and settling time of 1µs to 0.01%. With its 10MHz gain bandwidth and 850kHz full power BW, the OP-42 combines high speed with accurate DC performance.

OP-42		
V_{OS}	750µV	Max
A_{VOL}	500,000	Min
CMR	88dB	Min
TCV_{OS}	10µV/°C	Max

Guaranteed unity gain stability, capacitive load tolerance, and clean transient response make the OP-42 easy to use . . .

. . . with only 6mA of supply current max.

Available now. For more information circle the inquiry number or call us. 1-800-843-1515. In California, call 1-800-826-9664.

Precision Monolithics Inc.
A Bourns Company
Santa Clara, California, USA
408-727-9222

FRANCE: 01-40 03 35 93; **GERMANY:** 0711-22 93 0; **BENELUX:** 070-87 54 04; **SWITZERLAND:** 042-33 33 33; **UNITED KINGDOM:** 01-572 65 31; **HONG KONG:** 0-4992688; **JAPAN:** (03) 234-1411; **ARGENTINA:** 46-5776/0628/0864/2214; **AUSTRALIA:** (02) 439-4655; **AUSTRIA:** 0222-43 26 39; **DENMARK:** 02-98 63 33; **FINLAND:** 90-75 06 00; **INDIA:** 222-999; **ISRAEL:** (972) 3-922 39 88; **ITALY:** 02-569 57 46; **KOREA:** (02) 244-7492; **NORWAY:** 02-83 02 20; **SINGAPORE:** 747-6188; **SPAIN:** 01-405 42 13; **SWEDEN:** 08-768 05 60; **TAIWAN:** (02) 752 2200; **YUGOSLAVIA:** 041-42 37 46

® PMI

The precision solution.

CIRCLE NO 89

DESIGN IDEAS

September 4, 1986
Kurt W Christner, Carson City, NV. "IC emulates many types of logic gates."

September 18, 1986
Jerold R Thompson, Sperry Corp, Salt Lake City, UT. "Software provides rapid parity check."

October 2, 1986
Bobircă Florin Daniel, The Electronic Research Institute, Bucharest, Romania. "Circuit converts voltage ratio to frequency."

October 16, 1986
Damian G Bonicatto, Hibbing Electronics Co, Hibbing, MN. "Reset circuit solves brownout problems."

October 30, 1986
Doug Farrar, Apple Computer Inc, Cupertino, CA. "VCO generates frequencies above 40 MHz."

November 13, 1986
Mark Rumreich, RCA Corp, Indianapolis, IN. "Resistors provide nonlinear pot tapers."

November 27, 1986
Jim Wojcik, Allen-Bradley Co, Highland Heights, OH. "Arbiter lets two µPs use common RAM."

December 11, 1986
Andrew Dart, Trans-Texas Telegraph Co, Duncanville, TX, and **Richard Kihn,** KSDM TV, Beaumont, TX. "TV sync generator acts as clock timebase."

NOW YOUR TWO FAVORITE TABLOIDS COME TOGETHER IN ONE HOT NEWSPAPER...

EDN NEWS
NEWSBRIEFS
DSP Board Fits IBM PC
Power MOSFET Makers Boost Electrical Specs
The Temptations of Temping

EDN NEWS

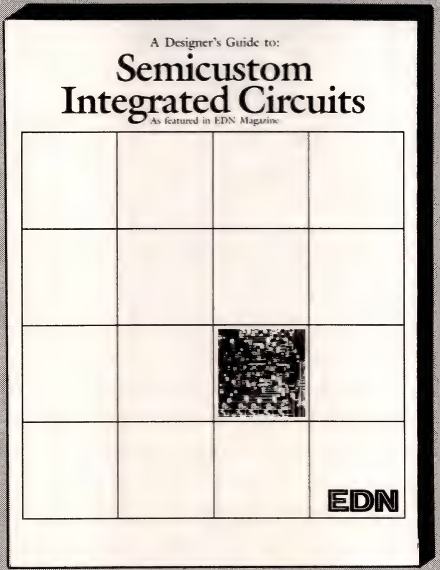
EDN Product News and EDN Career News, EDN's two tabloid editions, have merged to form EDN News...bringing you all the hottest news of products, technology, and careers.
EDN News mails once a month to EDN's U.S. and Canadian circulation. Which means that EDN News and EDN magazine together give you near-weekly coverage of the electronics industry!

HOT NEWS OF PRODUCTS
The focus of EDN News is on hot products that will have the most powerful impact on the way you do your job. EDN News covers the best products on the market, how they evolved, and why. Plus, it now covers the industry events that drive product technology and hence product introductions.

HOT NEWS OF CAREERS
In a separate section, EDN News keeps you abreast of professional developments and job openings in the electronics field. It carries editorial aimed at your career and professional growth. Editorial that will help you find a job and keep it.

EDN News. Hot News of Products, Technology, and Careers

You are only nine chapters away from understanding Semicustom IC design



A Designer's Guide to:

Semicustom Integrated Circuits

As featured in EDN Magazine

EDN

Learn how to design a semicustom IC with *A Designer's Guide to Semicustom Integrated Circuits.* Based on EDN's own design experience, this nine-chapter booklet outlines the complete procedure used to design, fabricate, and test EDN 1, a chip with a 1200 equivalent-gate complexity. You'll not only learn the steps to take when creating ICs, but also the design/cost analyses and vendor-interface methods that lead to successful semicustom chips.

Mail coupon to:
Semicustom IC Reprints
EDN Magazine
Cahners Building
275 Washington Street
Newton, MA 02158-1630

Please send ______ copies of *A Designer's Guide to Semicustom Integrated Circuits* (96 pages)
☐ $6.95 UPS ☐ $8.96 non USA
(Bank draft only)

Check or money order made out to **EDN REPRINTS** must accompany each order. No COD. Mass residents add 5% sales tax.

Please print clearly. This is your mailing label.

NAME ______________________________

TITLE ______________________________

COMPANY ______________________________

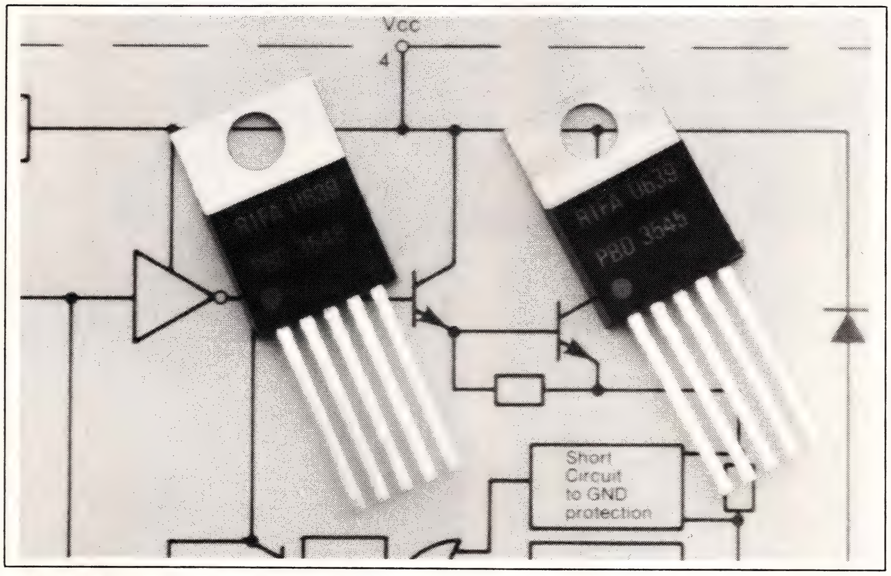
ADDRESS ______________________________

CITY ______________ STATE __________ ZIP __________

EDN031887

NEW PRODUCTS

COMPONENTS & POWER SUPPLIES



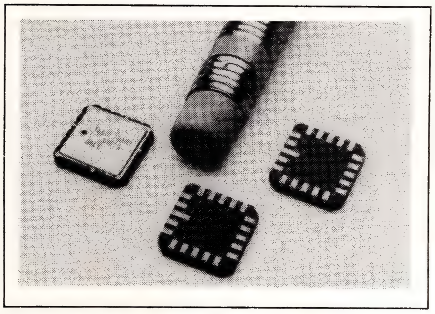
CURRENT DRIVERS

- *Protected for inductive loads*
- *Offer switching rates to 10 kHz*

The PBD 3545 and 3548 are 2A sink and source drivers, respectively. They feature short-circuit protection and a status output that indicates the load on an open circuit or a short circuit to either V_{CC} or ground. Internal protection diodes are provided to handle inductive-load switching. A temperature shutdown function limits the chip temperature to 130°C. During short-circuit load conditions, the output will be latched to zero at a speed fast enough to allow switching rates to 10 kHz. The supply voltage is 45V max. Operation spans 0 to 70°C for the PBD 3545, and −40 to +85°C for the 3548. PBD 3545, $3.25; PBD 3548, $3.75 (100).

Rifa Inc, Box 3110, Greenwich, CT 06836. Phone (203) 625-7300.

Circle No 351



RESISTOR NETWORKS

- *Three basic sizes available*
- *Package power ratings as high as 1.2W*

Model TLCC resistor networks come in hermetically sealed, chip-carrier-style packages that are compatible with automatic-assembly equipment. The networks are available in three basic sizes, each of which comes in a choice of three schematics. The 01 schematic provides a choice of 15, 19, or 23 resistors; each resistor connects to a common terminal. The 03 and 06 schematics provide eight, 10, or 12 isolated resistors. Resistance values range from 1 to 100 kΩ. Power ratings range as high as 1.2W per package for 24-terminal models. Individual resistors have 50-mW (01) and 100-mW (03 and 06) power ratings. Tolerances of ±2, ±1, ±0.5, and ±0.1% are standard, and the temperature coefficient equals ±25 ppm/°C. A typical 20-terminal, 03-schematic model with a ±2% tolerance, $9.53 (1000). Delivery, 12 weeks ARO.

Dale Electronics Inc, 2064 12th Ave, Columbus, NE 68601. Phone (402) 371-0080.

Circle No 352

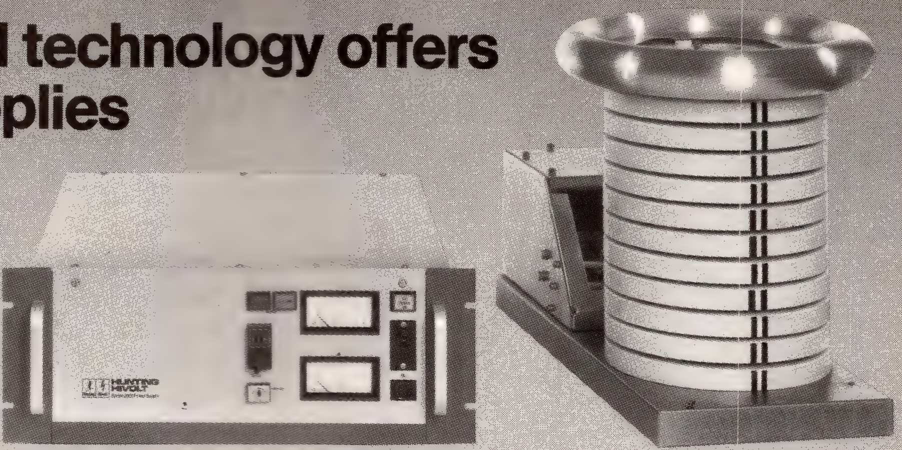
THERMOMETERS

- *Dual-range capability*
- *Industrial-grade construction*

The industrial-grade construction of the Model 865 and Model 866 thermistor thermometers includes a high-impact ABS plastic case that can withstand a 6-ft drop. The 865 measures temperature from −70 to +300°F in two ranges. One range measures temperature from −70 to +300°F with a resolution of 1°F and an accuracy of ±(0.3%+1°F). The other range measures temperature from −70 to +199.9°F with a 0.1°F resolution. The accuracy equals ±(0.3%+1°F) from −70 to −40°F, and ±(0.3%+0.5°F) from −40 to +199.9°F. Model 866 measures temperature from −55 to +150°C with a 0.1°C resolution. The accuracy equals ±(0.3%+0.6°C) from −55 to −40.1°C, and ±(0.3%+0.3°C) from −40 to +150°C. The thermistor value at 25°C (77°F) equals 2252Ω. The instruments are powered by a 9V battery; an alkaline battery provides 350 hours of continuous operation. $159.

Tegam Inc, 7230 N Ridge Rd, Madison, OH 44057. Phone (216) 428-7505. TLX 205188.

Circle No 353



Our advanced technology offers HV power supplies for all applications.

Even the most demanding high voltage power supply applications are easily accommodated by Hunting Hivolt.

Select from our Series 2000—producing reliable outputs up to 200kV at 10mA for ion implantation equipment, for instance.

Or, if you need more, for the same type of application we can offer up to 10kW of solid state power, from tried and tested sources. And, each compact enough to be hand carried!

Again, if your requirement is for a laboratory or general purpose supply, you may equally benefit from our leading edge technology. View our ranges of special general purpose supplies and modules.

Full data is readily available from our office. Call today! You'll find we deliver in more ways than one.

Hunting | Hivolt

HUNTING HIVOLT

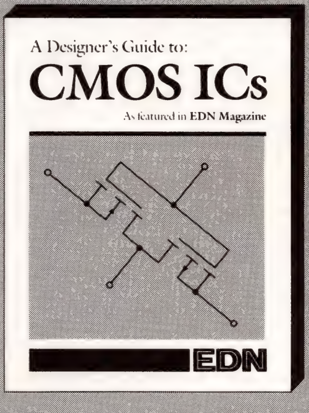
YOUR POWERFUL PARTNER

Hunting Hivolt, 1008 West Ninth Avenue, King of Prussia, PA 19406, USA
Tel: (215) 265 7462. Facsimile: (215) 265 1982.

Hunting Hivolt Limited, Riverbank Works, Old Shoreham Road,
Shoreham-by-Sea, West Sussex, England BN4 5FL.
Tel: (0273) 454511. Telex: 87466. Facsimile: (0273) 454471.

51118

CIRCLE NO 29



SEE WHAT A *DIFFERENCE* CMOS MAKES!

CMOS is fast becoming the chosen technology for developing integrated circuits. That's because CMOS ICs are able to implement ultra-complex system-level functions on a chip!

Now you can meet the special challenges posed by this new breed of ICs with ***A Designer's Guide to CMOS ICs***. You'll learn the advanced design and fabrication techniques required. Plus the latest linear and digital CMOS ICs available.

EDN031887

Mail coupon to: CMOS IC reprints — **EDN Magazine**
Cahners Building
275 Washington Street
Newton, MA 02158-1630

Please send ________ copies of ***A Designer's Guide to CMOS ICs*** (92 pages)

☐ $6.95 UPS ☐ $10.95 non USA **(BANK DRAFT ONLY)**

Check or money order made out to **EDN REPRINTS** must accompany each order. No COD. Mass. residents add 5% sales tax.

Please print clearly. This is your mailing label.

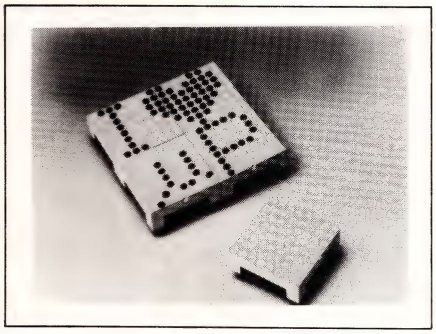
NAME ____________________

TITLE ____________________

COMPANY ____________________

ADDRESS ____________________

CITY ____________ STATE ______ ZIP ________



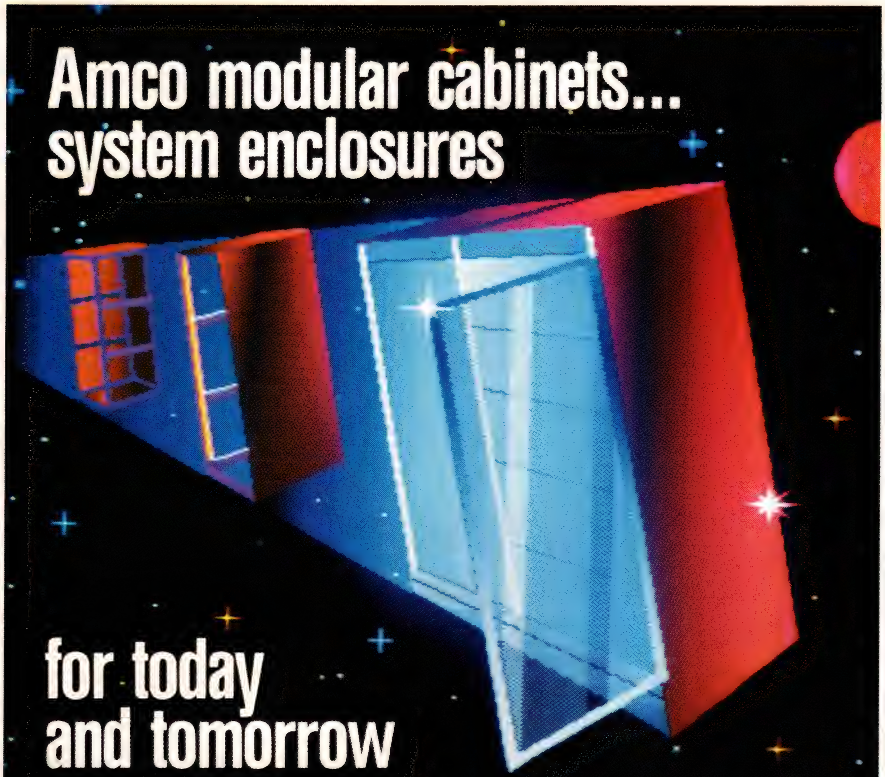
DISPLAYS

- *Readable from 35 ft*
- *Offers high alphanumeric flexibility*

The PD1165 (high-efficiency red) and PD1167 (green) programmable 8×8-dot matrix displays include built-in CMOS control circuitry that consists of LED drivers, multiplexers, RAM, and display-attribute features. Because of their 1.1-in. character height and 75° viewing angle, they are readable from 35 ft. They can display a variety of typefaces and alphabets, including script, Roman, Gothic, Japanese, Chinese, and Cyrillic characters. The units are XY stackable and cascadable (built-in synchronizing circuitry forms a display panel of any size). Specs include a 4.5 to 6V dc supply-voltage range, a −20 to +70°C operating range, and 1.6W power dissipation. PD1165, $27.60; PD1167, $30.35 (100).

Siemens Components Inc, Optoelectronics Div, 1900 Homestead Rd, Cupertino, CA 95014. Phone (408) 725-3548.

Circle No 354



Amco modular cabinets... system enclosures

for today and tomorrow

From start-up through any number of expansions, AMCO can provide you with a modular cabinet system that goes beyond your expectations. That's because AMCO has the depth of products, the engineering capability and the manufacturing know-how...combined with experience and expertise that has out-paced all others for over 40 years.

AMCO's general **Catalog 800** and our fast shipment **Catalog 500-A** are full of ideas and ways to help you select enclosure configurations for virtually any application... and make installation more economical and space-efficient.

Call TOLL-FREE, 1-800-833-3156 or write today.

Over Four Decades

AMCO®

AMCO Engineering Co.
3801 North Rose St.
Schiller Park, IL 60176-2190
in Illinois call (312) 671-6670

TWX: 910-227-3152
FAX: 312-671-9496

CIRCLE NO 30
See Us at Electro Booth 2035

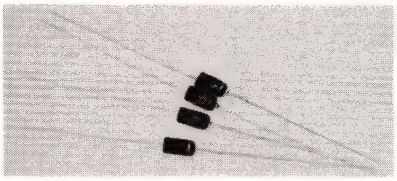
CONNECTOR SHELLS

- *Plastic shell matches die-cast shell for RFI/EMI shielding*
- *Side-lock construction permits easy cable termination*

Complying with IEEE-802.3 requirements and US and European RFI/EMI shielding standards, these plastic connector shells for Ethernet drop cables offer RFI/EMI shielding protection equivalent to die-cast covers. They accept 15-way subminiature D connectors and feature a side-lock construction with a cable ferrule that allows easy cable termination. They are available in a range of colors; you can have your company logo molded into the plastic shell—in most cases at no extra cost. Approximately $1.65.

Ossi Connectors Ltd, Unit C2, Priors Court, Priors Haw Rd, Corby, Northants NN17 1YG, UK. Phone (0536) 200963. TLX 265871.

Circle No 355



TUNING DIODE

- *14:1 min capacitance change*
- *Meets MIL-STD-19500 specs*

Over a 1 to 10V reverse-bias voltage range, the Type MV1401 tuning diode has more than a 14:1 change in capacitance. With its nominal 1V capacitance of 550 pF, the diode lends itself to broad tuning in the AM band and at somewhat higher frequencies. It has a reverse-voltage rating of 12V, and leakage at 10V measures less than 0.1 μA. Measured at a 2V reverse bias and a frequency of 1 MHz, the figure of merit (Q) equals 200 min. The diode comes in a DO-14-type glass package and meets MIL-STD-19500 environmental specifications. $5.85 (100).

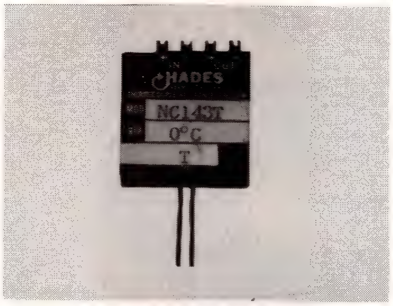
MSI Electronics Inc, 34-32 57th St, Woodside, NY 11377. Phone (718) 672-6500. TLX 426407.

Circle No 356

REFERENCE JUNCTION

- *Operates over −65 to +125°C*
- *Handles all thermocouple materials and power sources*

The Model NC143 thermocouple reference junction is available with any reference temperature setting required, and it can accommodate all thermocouple materials and power sources. Because the module is a miniature full-bridge junction with two mounting holes and either solder terminals or leads, it eliminates the need for ice or electromechanical temperature-simulation devices. The unit is externally energized by 1, 1.35, 5, or 10V dc, as required. Power consumption is as low as 100 μW. Operation spans −65 to



Amco styling and accessories...

quality that exceeds your most exacting standards

• Enclosure Panels • Grilles, Louvered and Perforated Panels • Fixed and Sliding Shelves • Modem Shelves • Mounting Channels • Chassis Guides • Base Plates • Support and Mobility Accessories • Security Accessories • Hardware

Panels and Mounting Accessories
Interface Styling Trim
Louvered Rear Door
Plug Mold
Open Rear Wiring Area
Blank Instrument Panel (top & bottom)
Panel Mount Modem Shelf
Plexiglass Door
Pull-Out Writing Surface/Drawer
Conventional Shelf
Panel Mounted Blower
Base Plate
Panel and Equipment Mounting Channels
Dual Mounting Flange for Panel and Equipment or Slide Mounting
19" Panel Mounting in 24" Panel Width Frame
Front Panel Mounting Flange Only
All Mounting Channels Available Hole Punched or 10-32 Tapped

Call TOLL-FREE, 1-800-833-3156 or write today.
Ask for: CATALOG 800

"Quality is No Accident"

AMCO Engineering Co.
3801 North Rose St.
Schiller Park, IL 60176-2190
in Illinois call (312) 671-6670

AMCO®

TWX: 910-227-3152
FAX: 312-671-9496

CIRCLE NO 30
See Us at Electro Booth 2035

IRC IS BACK!

Yes, we're the same IRC you've been turning to for top-quality, state-of-the-art resistive devices for over 60 years.

The plain fact is, we've never really been away.

For the past two decades, we were part of TRW Electronic Components Group. But you didn't forget us. You still demanded "TRW/IRC" resistors for your most critical circuit designs. (And we appreciate it!)

Now, we're again using our original name — IRC — for our broad line of resistive products. Which makes it easier for you to specify superior-quality resistors. And makes it simpler for your overworked purchasing agent to order from us.

For the most reliable source, just say: ***IRC.***

We have the total backing of the Crystalate Group, one of the U.K. and Europe's finest producers of electronic components and high-tech products. Plus the technological support of a sister company — Welwyn Electronics, the U.K.'s largest manufacturer of resistive products and hybrid circuits since 1937.

IRC. Remember our name. We're destined to be a major factor in the success of your future circuit designs. With axial and radial leaded parts, plus space-saving, surface-mounted resistors of every description. Flat and cylindrical chips. Unique SMD power wirewounds. Small-outline leadless networks. TaNFilm® flat-pack networks. Chip carrier networks. And custom thin-film and thick-film hybrid circuits to meet your cost-reduction and size-reduction goals.

For all your resistive products and hybrid circuit requirements, let us share our technical innovation and combined century-plus of experience with you. Write to: IRC, Inc., Greenway Road, P.O. Box 1860, Boone, NC 28607. Or phone: (704) 264-8861.

You'll like the way we do business. Besides, our name is easy to spell.

The Resistor People **IRC**

(Formerly TRW Resistive Products Division)

+125°C, and stability is better than ±0.25° at any stabilized ambient temperature between −54 and +100°C. Compensation is available for all thermocouple materials. The output impedance equals 250Ω max for standard units, but other impedances are available on request. $53.10 (100).

Hades Manufacturing Corp, 151 Verdi St, Farmingdale, NY 11735. Phone (516) 249-4244.

Circle No 357

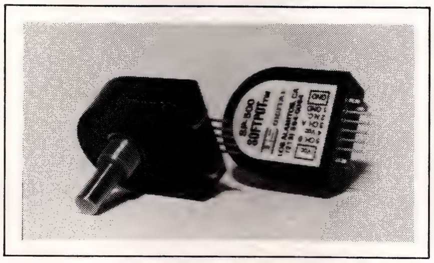
OPTICAL ENCODERS

- *Draw less than 40 mA*
- *Performance unaffected by aging*

The SP-360, SP-500, and SP-512 optical encoders yield 360, 500, and 512 cycles/revolution, respectively. Their internal electronics, which draw less than 40 mA from a 5V supply, include the single LED, photodetector array, and signal processors necessary to produce the devices' 2-channel quadrature TTL-compatible outputs. A rugged Mylar disk, a brass bushing, a stainless-steel shaft, and gold contacts complete the assembly. Each encoder is unaffected by aging or 10% voltage variations; they operate over −40 to +100°C. The torque-loaded shaft in each device simulates the feel of a potentiometer for front-panel applications. A free-spinning shaft is also available. $27 (100).

US Digital Corp, 12371 Kensington Rd, Los Alamitos, CA 90720. Phone (213) 594-0094.

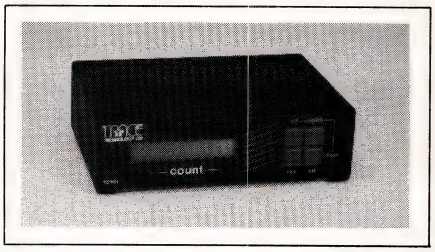
Circle No 358



PANEL COUNTER

- *Provides eight input channels with programmable alarm levels*
- *μP controlled with battery backup*

The TC101 counter module allows you to count events on as many as eight inputs simultaneously, with a maximum count capacity of 9,999,999 on each input channel. The ability to preset step sizes on each channel suits the unit to batch-counting applications, and four alarm outputs allow you to generate alarms from any of the eight input channels. You set up the unit via a menu-driven procedure through



THE PERFECT UNION FOR REAL-TIME DEVELOPMENT

Heurikon's LINK/X™ Real-Time Development System makes your real-time headaches a thing of the past. LINK/X provides bi-directional communication between UNIX™ and multiple processors running under the Hunter and Ready VRTX® real-time executive. LINK/X lets you develop code under UNIX, download to VRTX, test and debug—all over the system bus or serial link!

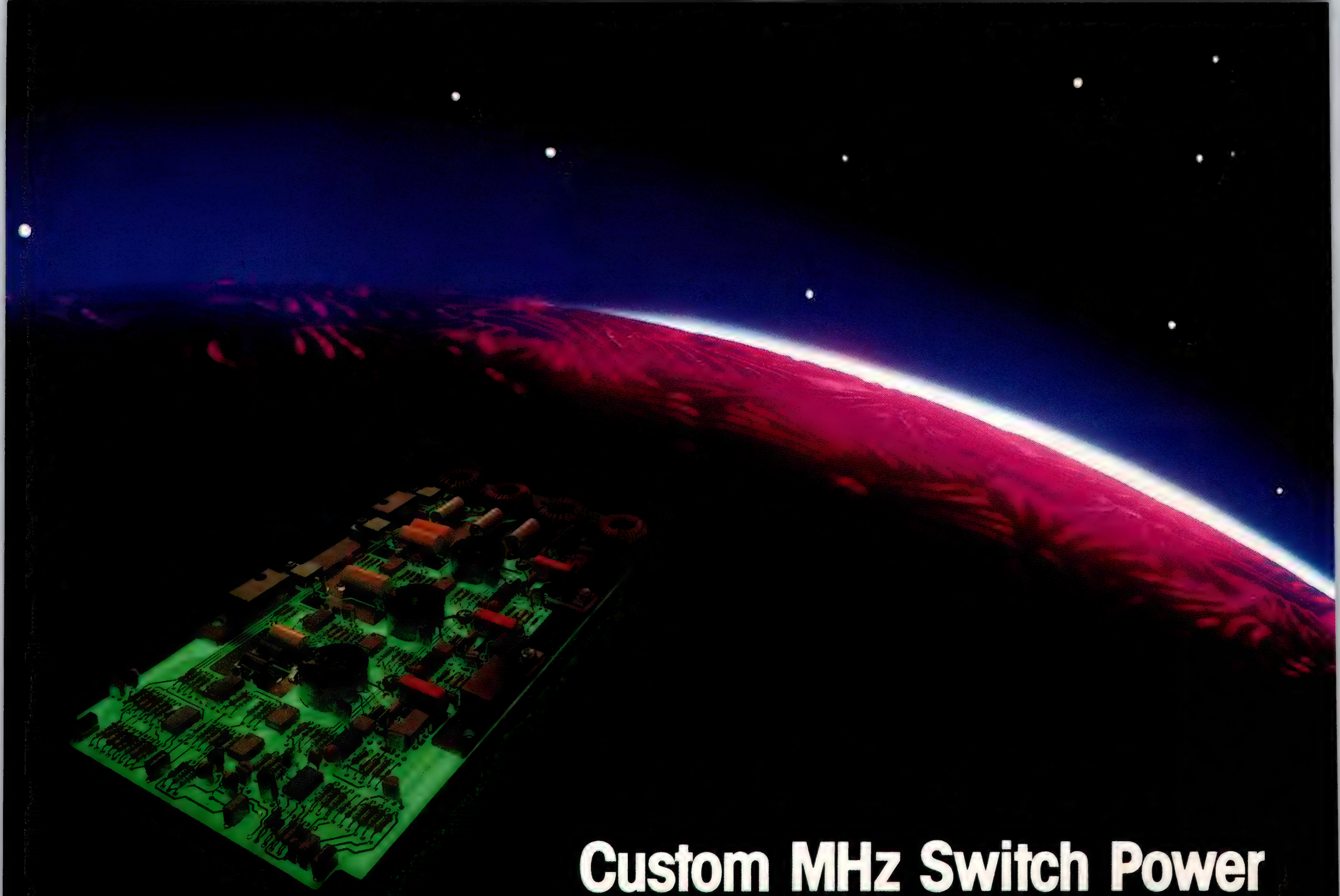
With LINK/X you will never need to compromise on performance again. Using Heurikon's powerful MC68010 or MC68020, Multibus™ or VME microcomputer board families, systems can be configured to meet the most demanding application requirements. Customized versions can include up to 16 VRTX processors with a host of peripherals.

Cure your real-time development headaches now! Call Heurikon at **1-800-356-9602 (ext. 397)** and ask for LINK/X. Heurikon Corporation, 3201 Latham Drive, Madison WI 53713.

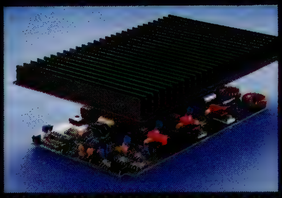
LINK/X is a trademark of Heurikon Corporation.
UNIX is a trademark of Bell Laboratories, Inc.
VRTX is a registered trademark of Hunter and Ready.
Multibus is a trademark of Intel Corp.

HEURIKON CORP.

CIRCLE NO 31



Custom MHz Switch Power from Standard Circuitry



U.S. Pat. No. 4,441,146 and 4,415,959

New Zero Current Switching Technology
Saves Space • Reduces Heat • Increases Reliability

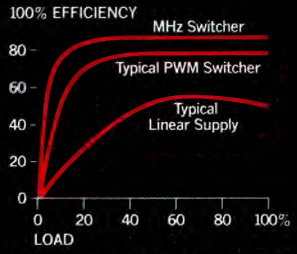
Lorain can put this high frequency converter technology to work for you. Compact, lightweight, multi-cell, zero current switching forward converters deliver up to 200 Watts per cell. All custom designed to your specific communications application from standard circuitry. And cost effective, too!

Over 30 Watts per Cubic Inch

Zero current switching provides the highest power densities available, compared to present day switch mode conversion technology.

80–88% Efficient

Zero current switching significantly reduces heat loss and stress on switching elements. Higher conversion frequencies result in increased life and reliability. Take advantage of Lorain's design and application expertise in high frequency power conversion. We will meet your specifications . . . customizing standard circuitry . . . including bells and whistles. Contact us for additional information, or send us your requirements.



Watts per Cubic Inch

Lorain Technology . . . Working Ahead to Keep You On Line

LORAIN PRODUCTS

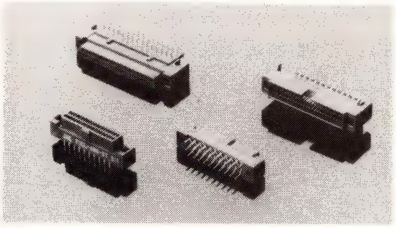
1122 F Street
Lorain, Ohio 44052
216-288-1122, Ext. 595

RELIANCE COMM/TEC

four front-panel pushbuttons, and you can select any individual channel count for display. You can also display the sum total of events that have occurred on all eight inputs. A security feature limits operator access for viewing and clearing the display, and battery backup of the unit is also provided. The TC101 has panel dimensions of 160×50×110 mm. £120 (10).

Trace Technology Ltd, Swan Works, Box End Rd, Bromham, Beds MK43 8LT, UK. Phone (0836) 261643.

Circle No 359



CONNECTORS

- *Handle high-density applications*
- *Contact pitch of 0.05 in.*

PICL Series 2-piece connectors are designed for board-to-board applications. They feature a mating-side contact pitch of 0.05 in.; contact tails have a 0.1-in. contact spacing with four staggered rows 0.075 in. apart. Combinations of straight and right-angle male and female connectors allow vertical, horizontal, and parallel board connections. Devices are available in 30-, 40-, 50-, and 60-contact layouts. Specs include a 0.5A current rating, a 1000V ac dielectric withstanding voltage, a $10^8\Omega$ min insulation resistance, a 25-mΩ max contact resistance, and a −40 to +80°C operating range. From $1.75 (1000). Delivery, stock to eight weeks ARO.

JAE Electronics Inc, 1901A E Carnegie Ave, Santa Ana, CA 92705. Phone (800) 523-7278; in CA and AK, (714) 250-7278. TLX 681438.

Circle No 360

MIXER

- *Spans 500 kHz to 500 MHz*
- *Measures 0.25×0.25 in.*

This surface-mount mixer, the RMS-1, spans a 500-kHz to 500-MHz frequency range and measures only 0.25×0.25 in. It's designed to work with a local-oscillator (LO) output of +7 dBm, but it can oper-

TUSONIX

If you're looking for excellence in Technical Ceramic Dielectrics . . .

Tusonix has 100,000 variations . . . in formulations, sizes and shapes

Our ceramic formulations, developed over a 50 year period, consist of hundreds of different bodies and more than 100,000 variations in capacitance values to 1 mfd . . . and to 40,000 Volt ratings.

We start with the basic ceramic powders, inspect and blend them to unique dielectric formulations. Stringent quality controls are maintained from blending through firing. Thousands of various sizes and styles are available from stock for your sampling requirements.

So if you're looking for quality ceramic dielectrics look to Tusonix first. Please call us at 602-744-0400.

TUSONIX
P.O. Box 37144, Tucson, AZ 85740-7144
602-744-0400 Telex: (RCA) 299-640

CIRCLE NO 32

ate well at plus or minus several decibels from this level. Conversion loss is 8.5 dB min across the bandwidth. LO to RF isolation (+7 dBm LO power) is better than 44 dB at 62 MHz and greater than 24 dB at 531 MHz. You can attach the mixer to a pc board using conventional manual soldering or with automatic equipment. The mixer is also available in a tape-and-reel format to accommodate pick-and-place machines. $8.95 (100).

Mini Circuits, Box 166, Brooklyn, NY 11235. Phone (718) 934-4500.

Circle No 361

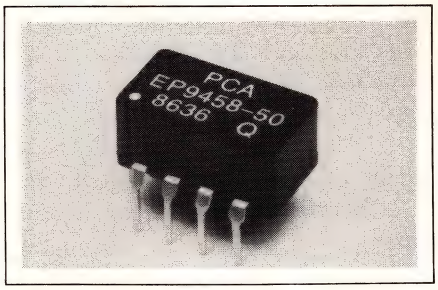
EDGE CONNECTORS

- *Eliminate need for soldering*
- *Offer 15 to 65 positions*

These compliant-pin card-edge connectors reduce assembly time and costs by eliminating the need for soldering. The flexible twin-beam construction in the compliant section and the rounded surfaces provide a gas-tight joint. You can remove and replace individual contacts several times without affecting electrical or mechanical performance. These connectors are interchangeable with devices that have a 0.1×0.2-in. grid spacing. They range in size from 15 to 65 positions and feature selective gold plating. The connectors are available in a number of configurations (including high and low profile) and a choice of card-slot depths, termination lengths, and open or closed ends. Contacts fit on 0.062-, 0.093-, and 0.125-in.-thick pc boards; the maximum insertion force equals 40 lbs, and the minimum retention force per contact is 10 lbs. $0.03 per contact (10,000).

Viking Connectors Co, Box 2379, Chatsworth, CA 91311. Phone (818) 341-4330.

Circle No 362



DELAY LINES

- *Designed for high-density applications*
- *Rise times equal 4 nsec*

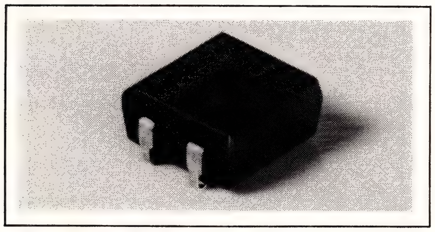
Measuring 0.28×0.25 in., EP9458 5-tap, TTL-compatible delay lines are intended for applications where pc-board space is at a premium. The 15 units in the family provide total delay times of 25 to 250 nsec with accuracies of ±5% or 2 nsec (whichever is greater). For all devices, the five taps are located at equal delay increments; the 200-nsec unit has taps at 40, 80, 120, and 160 nsec. A Schottky TTL inverter buffers the

VHS Cassette T-120
0/08/01 M·A·S·F·G
Save of structured-removable packs
B8733, B2183, B4519, B7633, B3511,
B2510, B3170, B7335, B3526, B3499, B2183,
B9811, BC815, BC954, B7511

delay-line input and five output taps. Output buffers can drive TTL, low-power Schottky, or Schottky loads. The rise time is 4 nsec max. Operation spans 0 to 70°C. $2 (1000). Delivery, stock to six weeks ARO.

PCA Electronics Inc, 16799 Schoenborn St, Sepulveda, CA 91343. Phone (818) 892-0761.

Circle No 363



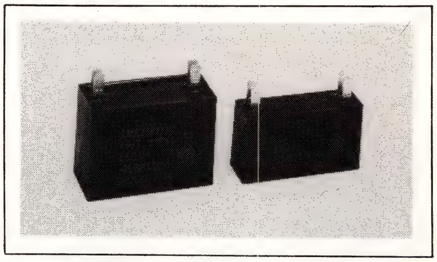
OSCILLATOR

- *1- to 50-MHz frequency range*
- *Offers a 3-state output*

The Model KSO-HC surface-mount clock oscillator features a 1- to 50-MHz frequency range and can drive loads as high as 100 pF. It's compatible with TTL and CMOS loads and offers a 3-state output. The oscillator features an initial tolerance of ±100 ppm; an optional 45/55 duty-cycle ratio is available for tight-symmetry applications below 25 MHz. The operating range equals 0 to 70°C. The unit measures 12.45×11.45×5.5 mm. $3.85 (10,000).

Kyocera Northwest Inc, Electronic Components Group, 11425 Sorrento Valley Rd, San Diego, CA 92121. Phone (619) 454-1800.

Circle No 364



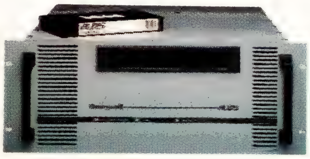
CAPACITORS

- *Flame retardant to UL 94V-0*
- *Constructed of self-healing dielectric*

CME Series capacitors are constructed of metallized polyester dielectric, which is self healing and nonpolar. The capacitors feature a glass-fiber-reinforced, box-type plastic case that's flame retardant to UL specification 94V-0. Capacitance values range from 0.5 through 20 µF. Voltage ratings are 220, 250, 440, and 500V ac, and standard tolerances equal ±10, ±6, +10/−5, and +20/−5%. $0.932 (10,000) for a 5-µF, ±10%, 250V ac unit. Delivery, eight to 10 weeks ARO.

American Shizuki Corp, 21541 Blythe St, Canoga Park, CA 91304. Phone (818) 710-8555. TLX 662633.

Circle No 365



In the world of information storage, this is known as a warehouse.

Imagine storing up to 5.2 gigabytes of data on a standard T-120 VHS high-energy cassette. Now you can with Honeywell's new VLDS system (Very Large Data Store).

You no longer need thirty 10-inch reels of 6250 bpi 9-track computer tape. Or 5,200 double-sided 5¼-inch floppy disks. Or fifty-two 5¼-inch WORM optical disks. Just VLDS and a single standard VHS cassette.

VLDS provides a 4-megabyte-per-second sustained transfer rate, a media cost of less than .21¢ per megabyte, and a bit error rate of 10^{-12}. And to assure easier, cost-effective system integration, optional high-performance imbedded controllers are available, including SCSI and VAX/VMS.

VLDS is the latest advancement in Honeywell's line of magnetic tape systems that have been unsurpassed in quality and support services for over 30 years.

For details on VLDS, and its OEM pricing, contact Tom Balue, Honeywell Test Instruments Division, Box 5227, Denver, CO 80217-5227. (303) 773-4491.

Together, we can find the answers.

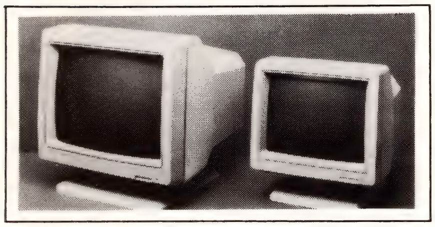
Honeywell

CIRCLE NO 33

© 1987 Honeywell Inc.

NEW PRODUCTS

COMPUTERS & PERIPHERALS

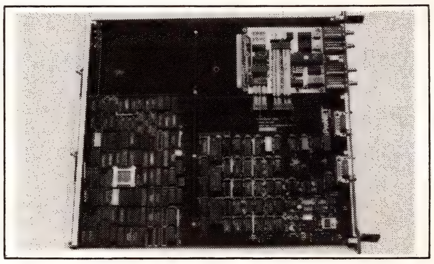


GRAPHICS MONITORS

- *Has elliptical-aperture lens*
- *Model achieves 0.2- to 0.4-mm convergence*

The HM-4119 and HM-4115 monitors feature the elliptical-aperture (EA) lens and HSA (Hitachi slit-winding with auxiliary coil) yoke technologies. Compared with conventional CRT lens techniques, the EA-type lens improves focus by 10%, the manufacturer claims. The HSA yoke achieves 0.3- to 0.5-mm convergence in the 19-in. HM-4119 and 0.2- to 0.4-mm convergence in the 15-in. HM-4115. Both monitors are 60-Hz noninterlaced color monitors with video bandwidths of 100 MHz. The deflection angle of each monitor is 90°, and the monitors use electrostatic focusing and electromagnetic deflection. The HM-4119 features 0.31-mm dot-trio pitch, and the HM-4115 has 0.28-mm dot-trio pitch. HM-4119, $3990; HM-4115, $2200.

Hitachi America Ltd, Office Automation Systems Div, 950 Elm Ave, Suite 170, San Bruno, CA 94066. Phone (415) 872-1902. TLX 176308. **Circle No 366**



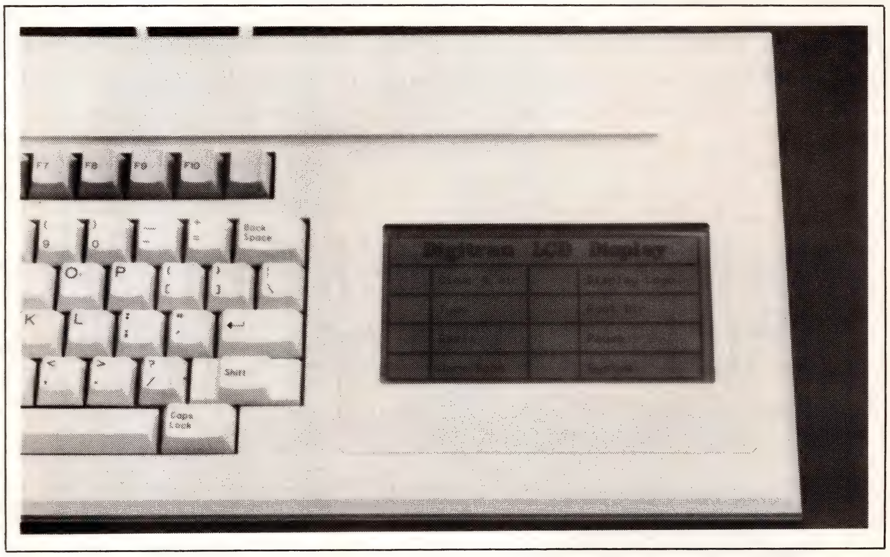
NETWORK BOARDS

- *Boards for Sun VME Bus link workstations*
- *Direct fiber-optic interface option*

The interface boards of the p1500 Series tie Sun VME Bus workstations into the vendor's Pronet-10 and Pronet-80 local-area networks. The boards are available with a basic interface and a choice of three fiber-optic links that connect directly to the interface boards. Device-driver software is provided along with the boards (these packages complete the integration of the boards into the LAN). The interface boards plug directly into a Sun workstation's backplane. The three varieties of fiber-optic interface are single fiber, dual redundant, and counter rotating. The basic Sun VME Bus interface for Pronet-10 (p1503) costs $2700; with single fiber (p1504), $3800; with dual-redundant fiber (p1505), $4100; with counter-rotating fiber (p1506), $4350. The basic Pronet-80 board (p1583), $6900; with single fiber (p1584), $9100; with dual-redundant fiber (p1585), $10,000; with counter-rotating fiber (p1586), $10,400.

Protean Inc, Two Technology Dr, Westborough, MA 01581. Phone (617) 898-2800. TLX 928124.

Circle No 367



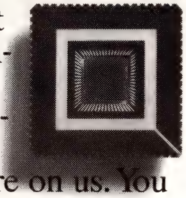
KEYBOARD

- *Programmable keyboard uses touchscreen LCD*
- *Comes in IBM PC/XT, PC/AT, ASCII, or custom formats*

The LCD Touch-Screen Keyboard combines an LCD touch panel with a main keyboard. The touch panel measures 5×2¾ in. You can use it as a cursor controller, a programmable keypad, or both. The keyboard is available in IBM PC/XT and PC/AT, ASCII, or custom formats. Using the keypad, you can incorporate macrokey words, short and long strings, or icons in programmed screen options. The bundled software allows you to develop screen formats directly from the keyboard, to increase the number of function keys without retooling, and to save menus or icons on multiple screens. A list of commands for custom menus is provided with the software. $395.

Xcel Corp, 3100 New York Dr, Pasadena, CA 91107. Phone (818) 791-5600.

Circle No 368



Did we say guaranteed?

That's right. Choose Plessey as your ASIC vendor and your circuit will work in silicon the first time, or all nonrecurring engineering costs are on us. You won't pay a penny for a design that doesn't fly.

Are we crazy to make such an offer? Hardly. Our first-time hit rate is a whopping 99%. When you see our approach to ASICs, you'll know why.

It all starts with CLASSIC,™ our easy-to-use software. From circuit compilation through schematic capture, to simulation and test, it keeps you in control of every step of the design process.

What can you do with CLASSIC? Everything from simple gate arrays to complex Plessey MEGACELL™ designs on ECL and CMOS. MEGACELL delivers full-custom performance at semi-custom prices—and semi-custom turnaround times.

Speaking of turnaround, our new 200,000 square-foot, 1.5-micron fabrication facility can easily handle your most demanding production needs.

Shouldn't you use an ASIC vendor that guarantees your ideas will get off the ground the first time? Call 1-800-247-4840 or 714-472-0303. Or write Plessey Semiconductors, 9 Parker, Irvine, CA 92718.

For free on-line information, dial 1-800-345-7335 with any 80-column ASCII terminal or PC and a 300 or 1200 baud modem (EVEN or IGNORE parity, 7 data bits, 1 stop bit). AT "Enter Response Code," type GR8ASICS. In Conn., dial 203-852-9201.

PLESSEY

ASICs from thought to finish.

Plessey and the Plessey symbol are trademarks of the Plessey Company plc.

CIRCLE NO 133

Unlike other innovations, first-time success with Plessey ASICs is guaranteed.

NIDEC APPLIES ADVANCED IC TECHNOLOGY TO BRUSHLESS DC FANS.

Custom chip replaces multi-component circuit board assembly for greatly improved reliability and control.

Until now, the performance of brushless DC fans has depended on a complicated "control center" consisting of 20 or more components mounted on a printed circuit board. A revolutionary IC design developed exclusively for us by Sprague® has changed that—and moved brushless DC fan technology into a new generation.

A single chip incorporating "Hall" sensing and power electronics performs all commutation functions, replacing the printed circuit board assembly. Starting inrush current requirements are reduced for power supply savings. Easily accommodates various speed control methodologies to tailor output to variable thermal environments and acoustic requirements.

The result is a new standard of performance, reliability and control in fans from 2″ to 4½″. Only from Nidec-Torin.

For additional information on Nidec-Torin's wide range of tube axial fans, please call (203) 482-4422, ext. 502, or write Nidec-Torin Corporation, 100 Franklin Drive, Torrington, Connecticut 06790.

Nidec
Nidec-Torin Corporation

See us at the Show, Booth 2165-2167

CIRCLE NO 121

IMAGE BOARD

- *Allows you to connect a video camera to an IBM PC*
- *Transfers image via modem*

The Professional Image Board allows you to connect a home video camera to an IBM PC. Using readily available components, you can capture, manipulate, and transmit images. The computer can enhance a captured frame on a feature-by-feature basis and store it on a floppy or hard disk. You can then transmit the frozen pictures to remote computers via modem. $595.

ATronics International Inc, 1830 McCandless Dr, Milpitas, CA 95035. Phone (408) 943-6629.

Circle No 369

VME BUS ANALYZER

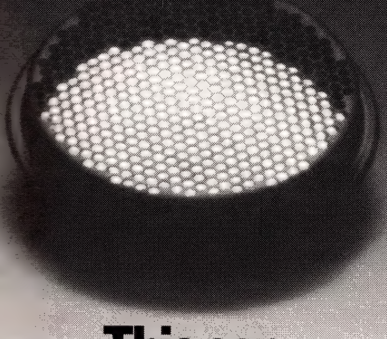
- *Monitors 72 VME Bus signals*
- *Operates in conjunction with a CRT terminal*

The VME Bus Tracer, a double-Eurocard board, is a testing and debugging tool for VME Bus systems. It has most of the features of a logic-state analyzer; it plugs directly into the VME Bus and passively monitors VME Bus activity. It has an onboard µP and operates in conjunction with a CRT terminal for control and display purposes. In addition, it includes a Centronics-compatible interface for hard-copy output of the captured trace data. You can clock the data capture memory synchronously or asynchronously at frequencies to 16 MHz. The analyzer can capture 1024 states of 72 VME Bus signals, including address, 16-bit data, handshake, and control lines. Its trigger facilities include the capability to capture only those data-bus transfers occurring either inside or outside of a specified VME Bus address range. Approximately $4900.

Vmetro a/s, Box 122, Leirdal, 1008 Oslo 10, Norway. Phone (47) 6906271.

Circle No 370

What can stop a 650-ton locomotive in its tracks, keep a 7-billion gallon tank from overflowing, and help a blind man cross the street?



This can.

The Polaroid Ultrasonic Ranging System is an accurate, highly sensitive way to detect and measure the presence and distance of objects from 10.8 inches to 35 feet.

It controls industrial robots. And safeguards operators. Measures room dimensions at the press of a button. Warns a truck driver that he's in over his head. And more.

Polaroid introduces a new Environmental Transducer. An improved ultrasonic transducer (available in a sturdy housing) can withstand exposure to a wide range of hostile environments: rain, heat, cold, salt spray, chemicals, shock and vibration. Yet it's just as sensitive as the original transducer used in millions of SX-70 Sonar Autofocus cameras.

Get a $2-million head start on your next product design. Polaroid spent over $2 million developing the Ultrasonic Ranging System. But now you can get this technology in our Designer's Kit for only $165. Or order just the individual components you need for your application.

How far can you take the technology? Call Polaroid's Applications Engineers at 617-577-4681 and find out.

How to get $2-million worth of technology for $165.

To order your Ultrasonic Ranging System Designer's Kit, please send a check or money order for $165 for each kit, plus all applicable state and local taxes, to: Polaroid Corporation, Ultrasonic Components Group, 119 Windsor Street, Cambridge, MA 02139.

_____ Please send me _____ Designer's Kit(s). _____ Please send more information.

EDN031887

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City ____________ State ______ Zip ______

Polaroid

"Polaroid", and "SX-70"®

Visit us at Booth 2045 at Electro '87

CIRCLE NO 34

LASERPATH FOR ONE DAY GATE ARRAY™ PROTOTYPES.

No one delivers gate array prototypes quicker than Laserpath, the One Day Gate Array™ company.

These are real, double-metal 2μ CMOS gate arrays. High performance like their popular counterparts from LSI Logic. Only delivered quicker. There's one for most applications.

Send a netlist from any industry-standard CAD system. It's that easy. And if you need a cell or function not already in our World Macrolibrary™, we'll create it...in one day.

For details, call Earl Watts at 408-773-8484.

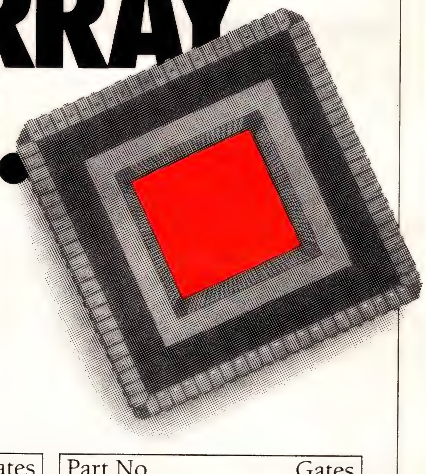
Part No.	Gates
LP7080L	880
LP7140L	1400
LP7220L	2200
LP7320L	3200

Part No.	Gates
LP7420L	4200
LP7600L*	6100
LP7840L*	8400
LP71000L*	10000

*Available in 1987

LASERPATH
ONE DAY GATE ARRAYS™

CIRCLE NO 35



COMPUTERS & PERIPHERALS

PORTABLE COMPUTER

- *Handheld computer with 8-bit μP*
- *Calculator functions included*

The Advanced Pocket Computer (APC) features an 8-bit μP, 64k bytes of internal memory, and expansion capability to 256k bytes of RAM and EPROM. It also has a full alphanumeric keyboard, an LCD organized as two lines of 16 characters each, and an RS-232C link, which operates at speeds from 50 to 9600 baud. The APC measures 5.6×3.1×1.1 in. and weighs 10 oz. The device uses a single 9V alkaline battery. In addition to computing and communications functions, the APC provides calculator and real-time date and time clocks. The computer's operating system and programming language reside in 32k bytes of ROM; 32k bytes of RAM are provided for data storage. The device's memory capacity may be expanded through the use of optional plug-in memory modules, which are available in capacities of 16k, 32k, 64k, or 128k bytes. $295. Delivery, four to six weeks ARO.

Hand Held Products, Box 2388, Charlotte, NC 28211. Phone (704) 541-1380.

Circle No 371

3-D DIGITIZER

- *Digitizes solids in a noncontact fashion*
- *Can digitize live subjects as well as inanimate objects*

The Rapid 3D Digitizer camera/computer digitizes any 3-D object regardless of its material composition, including live subjects. The camera circles the subject or object in 15 sec and obtains 500,000 points, which are reduced to 250,000 coordinates. You can then use the coordinates to reproduce the object for computer graphics or for solid modeling. You can also feed the information into a computer-controlled mill that cuts solid reproductions. Because the camera has no contact with the object being reproduced, the object is not deformed by the reproduction process. Resolution of the system is such that features as small as 0.028 in. can be captured in digital form on a 14-in.-diameter object. The system achieves an accuracy of 1% over the entire digitized surface. This figure means that any given feature will be within 1% of its actual position. $40,000. Delivery, 60 days ARO.

Cyberware Laboratory Inc, 2062 Sunset Dr, Pacific Grove, CA 93950. Phone (408) 373-6224.

Circle No 372

ESDI CONTROLLER

- *ESDI disk controller for the VME Bus*
- *Sustained data-transfer rates of 6M bytes/sec*

The Rimfire 3400 disk controller is an ESDI caching disk controller for the VME Bus. The device is capable of 20M-byte/sec burst-transfer rates from the controller to the bus by means of a short-burst FIFO gate array; it can transfer data at sustained rates of 6M bytes/sec. Disk access is enhanced through the use of a 512k-byte configurable cache memory and onboard firmware. The controller can review pending disk-access requests and optimizes seeks and caching by means of multiple circular-command queues in system memory. The controller runs four ESDI disk drives. $1995.

Ciprico Inc, 2955 Xenium Lane, Plymouth, MN 55441. Phone (612) 559-2034.

Circle No 373

DISPLAYS

- *Display terminals feature overscanned background*
- *Provide bit-mapped graphics*

The Visual 600 Integrated Image Display Station Series employs bit-mapped technology, which allows the display's internal 16-bit processor to address each pixel on the screen. (In contrast, purely text-based displays divide the screen into a matrix of character locations and do not permit the manipulation of individual pixels.) The 600 Series features a white-phosphor, dark-glass, nonglare flat screen that has a 70-Hz refresh rate with a horizontal frequency of 32 kHz. The screen has 1056×400-pixel resolution. From $695 to $725.

Visual Technology Inc, 1703 Middlesex St, Lowell, MA 01851. Phone (617) 459-4903.

Circle No 374

I/O FOR MAC

- *Links Macintosh to the STD bus*
- *Performs front-end I/O processing for the Mac*

The Model 3A SCSI/IOP adds an industrial I/O bus to the Macintosh Plus for industrial, scientific, and educational applications. The SCSI/IOP connects to the SCSI port of the

LASERPATH FOR LOW VOLUME PRODUCTION.

Now, get 1000, 100, 50, even 5 production gate arrays in as little as a week!

That's right. Thanks to Laserpath technology, you can get to market before your competition receives first prototypes. And develop new gate array-based products without a major commitment in time or money.

Most gate array houses avoid small production runs. We specialize in low volume production. We're set up to provide better service than you probably thought possible.

So don't delay. Call Earl Watts at 408-773-8484. Or write: Laserpath, 160 Sobrante Way, Sunnyvale, CA 94086. Ask for your *free* 550-page One Day Gate Array™ design manual and see what puts Laserpath a generation ahead of competition.

LASERPATH
ONE DAY GATE ARRAYS™

CIRCLE NO 74

New Kepco/TDK 150KHz Switching Power Supply, SERIES RBX

This brand new product of advanced Kepco/TDK technology squeezes more power into less space than you'll find most anywhere else. It's a highly efficient, FET-based, fast-responding switcher operating at 150KHz.

The Kepco/TDK Series RBX gives you remote on/off, remote voltage control, remote error sensing, overvoltage and undervoltage protection, rectangular current limiting, an "output OK" LED, selectable 115/230V input, and a current balance circuit which lets you parallel up to three units and have them share the load.

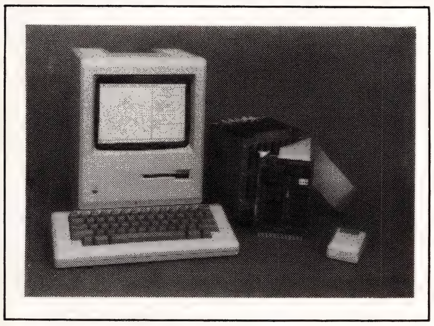
Model	RBX 02-120K	RBX 05-120K	RBX 12-50K	RBX 24-25K	RBX 48-12.5K
Volts	2V	5V	12V	24V	48V
Adjustment	1.6-2.2V	4.0-5.5V	9.6-13.2V	19.0-26.5V	38.4-52.8V
Amps	0-120A	0-120A	0-50A	0-25A	0-12.5A
OVP	2.6-2.8V	6.0-6.5V	14-14.5V	27-27.5V	55-57V
Current limit	125-145A	125-145A	52-60A	26-30A	13-15A
Efficiency	65%	80%	80%	85%	85%
Dimensions	3¼" x 7⅞" x 8 11/16" plus ¾" for connectors				
Safety	UL478, CSA C22.2-154				
Prices	$675 (OEM quantity discounts available)				

SEE US AT ELECTRO/87 • KEPCO BOOTH 2451, 2453

KEPCO®
THE POWER SUPPLIER™

For complete specifications and 144-page Kepco Applications Handbook and Full-Line Catalog, call or write Dept. JSF-12. KEPCO, INC., 131-38 Sanford Avenue, Flushing, NY 11352 USA
(718) 461-7000 • TWX #710-582-2631 • FAX: (718) 767-1102

CIRCLE NO 122



MAC Plus by means of a ribbon cable and plugs directly into an STD Bus card cage and backplane. Using the SCSI/IOP, the Macintosh acts as an STD Bus CPU. The CPU, in turn, provides access to a wide variety of real-time data acquisition and control interfaces, such as analog I/O, digital I/O, and ac power control. Firmware on the SCSI/IOP includes reading and writing I/O ports and memory, as well as downloading and executing tasks. The product supports the STD Bus interrupt architecture and performs the role of a front-end processor for a Macintosh real-time I/O. $119.

Ampro Computers Inc, Box 390427, Mountain View, CA 94039. Phone (415) 962-0230. TLX 4940302.

Circle No 375

DISK DRIVES

- *20M-byte, 5¼-in., removable-cartridge disk drives*
- *Available with either SCSI or ST506/412 interface*

The RH5260 (ST-506) and RH5261 (SCSI) 20M-byte, 5¼-in., hard-disk drives offer unlimited storage capacity by using hard-media cartridges that you can remove, transport, and interchange with other compatible drives. A proprietary track-runout compensation technique lets you adjust the disk to ensure cartridge interchangeability between units. The drives can read 10M-byte, 5130 cartridges. RH5260, $1046; RH5261, $1126.

Ricoh Systems Inc, 2071 Concourse Dr, San Jose, CA 95131. Phone (408) 946-6200.

Circle No 376

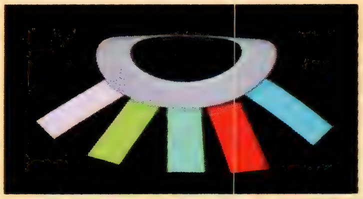
DIGITIZER

- *Optical page scanner for the Macintosh*
- *Provides black-and-white or halftone modes*

The TurboScan optical page scanner converts color or black-and-white text, handwriting, artwork, and photographs into digitized bit information for processing by the Apple Macintosh. The scanner digitizes with a maximum resolution of 300×300 dpi. The interface between the scanner and the Macintosh is an RS-232C/RS-422 port. The scanner provides two basic scanning modes: line-art mode for black-and-white materials and halftone mode for documents with continuous shad-

LSI electroluminescent (EL) lamps offer the designer a surface illumination alternative far superior to incandescent or other conventional light sources. And, whereas other makes of EL lamps may offer some of our product features, comparative tests prove that for long life, brightness, uniform light diffusion, color stability, resistance to moisture, heat, vibration and shock, no other EL lamps can match ours.

Thin, flexible and lightweight – Many shapes, sizes and colors
These rugged, solid-state EL lamps provide cool, uniform light across the entire lamp surface, eliminating the need for sockets, bulbs, diffusers and reflectors. Power consumption is small due to low current demand. A thin profile (.032″) permits high density packaging; and with IC-style leads available, lamps are compatible with PCBs. Although stocked in rectangular shapes for immediate delivery, we can design EL lamps in a variety of custom shapes and sizes including complex forms with multiple holes and cutouts. Available with pressure-sensitive adhesive on front or rear surfaces.



If you'd like a copy of our brochure, or have questions regarding EL applications, just call, write or TWX the LSI Marketing Department.

Luminescent Systems Inc.
Setting the Standard

Tel. (603) 448-3444 TWX 710-366-0607
Etna Rd., Lebanon, NH 03766

CIRCLE NO 36

At Holmberg, we're not handing you the same old lines.

What we are handing you is an outstanding line of high-quality connectors:

D-Subminiature
- All plastic and metal shell
- .590 and .318 footprints
- Crimp-snap
- Surface mount
- Press fit

Printed Circuit Card Edge
- Low cost cantilever contacts
- Modified bellows wire wrap

DIN
- Standard and reverse

Pin Headers
- Unshrouded, straight and right angles

Our design innovations can provide you with substantial cost savings plus the greatest variety of mounting options available. At Holmberg, we'll do whatever it takes to make your job successful.

CIRCLE NO 123

HOLMBERG® ELECTRONICS
The Innovation Connection

P.O. Box 37, Inman, SC 29349 • 803/472-4141 • Telex II 810/690-2302 • Fax No. 803/472-8568

ing. In the line-art mode, the scanner converts the scanned image, including any shades of gray, into a black-and-white image. In halftone mode, the scanner simulates the shades of the original image. $2395.

AST Research, 2121 Alton Ave, Irvine, CA 92714. Phone (714) 863-1333.

Circle No 377

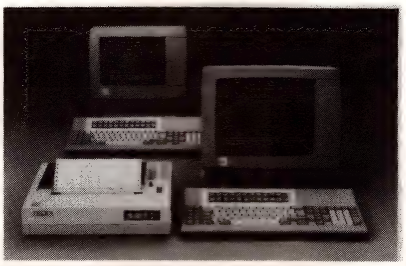
COMM BOARD

- *Onboard 80186 processor operates at 8 MHz*
- *Board works with Unix and MS-DOS*

Smartport is an intelligent serial-communications board for the IBM PC/AT and 80386-based computers. It incorporates an onboard 80186 processor operating at 8 MHz, contains 64k bytes of dual-ported RAM, and offers a choice of either four or eight RS-232C ports. The board operates under MS-DOS, Unix, or other multitasking/multiuser operating systems. The onboard processor and dual-ported RAM offload the serial-communications tasks from the PC. The PC loads a block of data into the dual-ported RAM and indicates to Smartport that it should be transmitted. The board buffers incoming data in the dual-ported RAM, where the data resides until the PC reads it out. The board uses an onboard operating system known as Box (Basic Onboard eXecutive), which provides the basic functions, such as baud-rate changing and status checking that are needed to use the board. The vendor supplies a technical manual that lists all the Box function calls and examples of their use. Source code is also available for custom applications. Smart-4, $895; Smart-8, $1295; PC-DOS and Xenix drivers, $25 and $50, respectively.

Arnet Corp, 476 Woodycrest Ave, Nashville, TN 37210. Phone (615) 254-0646.

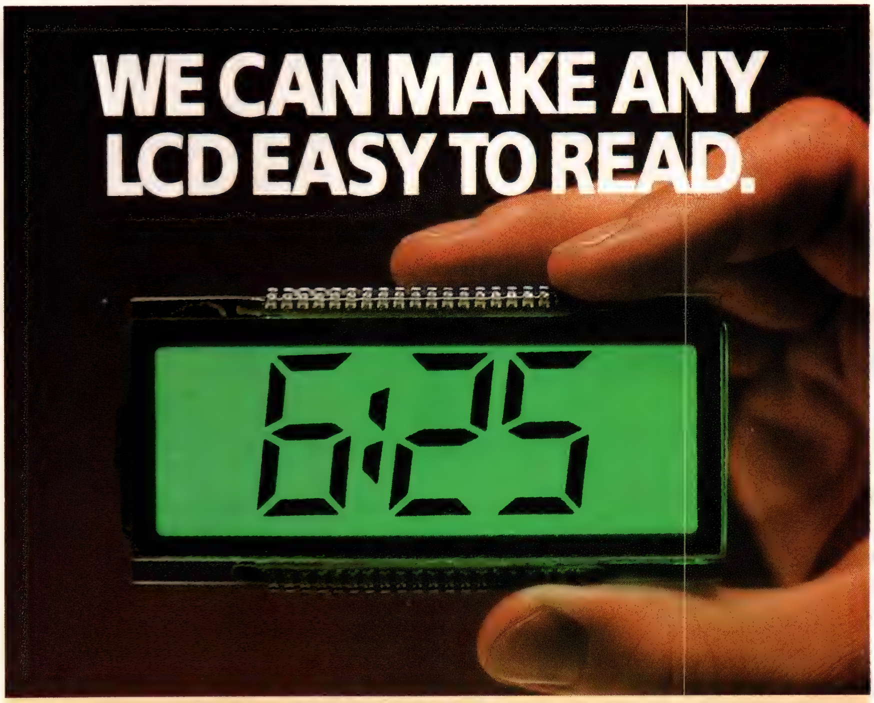
Circle No 378



TERMINALS

- *Display terminals include 122-key adjustable keyboards*
- *Printer terminals have speeds as high as 800 lines/minute*

The 3X Series includes four display and four printer terminals. Each of the display terminals displays as many as 1920 characters and has



Our thin, flexible electroluminescent lamps dramatically improve LCD readout by providing higher contrast and better visibility. A thin profile (.032") allows high density packaging, and pressure-sensitive adhesive can be supplied on front or rear surfaces for rapid assembly.

Uniform, cool light source in many shapes, sizes and colors
Our backlighting ELs emit even illumination across the entire lamp surface. They also eliminate the need for sockets, bulbs, diffusers or reflectors. Lamps are usually supplied in rectangular shapes, but we can create many custom shapes and sizes including complex forms with multiple holes and cutouts. With IC-style leads, lamps are compatible with PCB assembly. Eight standard colors are available and custom colors can be created.

If you'd like more information relating to LCD applications, just call, write or TWX the LSI Marketing Department.

Luminescent Systems Inc.
Setting the Standard
Tel. (603) 448-3444 TWX 710-366-0607
Etna Rd., Lebanon, NH 03766

CIRCLE NO 75

We want to power your next field test.

Sonnenschein
dryfit
Made in Germany
Sonnenschein Batterien Sonnenschein
Sonnenschein batteries Sonnenschein
Sonnenschein batterie Sonnenschein
Sonnenschein baterías Sonnenschein
Sonnenschein batterijen Sonnenschein
Sonnenschein batterier Sonnenschein

Let us show you how much a dryfit® sealed lead-acid battery can improve your product credibility! Just give us your application specs and we'll match them with the dependable dryfit battery you need.

Whether primary power or standby, dryfit is the right battery for the job. Because, dryfit is the original gelled electrolyte, re-combination sealed lead-acid battery. The only one of its kind with patent protected advantages for extended cycle life. The one with longer float life. And the one with the easiest charging techniques and the proven leak-proof construction!

Just look at the broad range of critical applications where dryfit outperforms ordinary batteries:

Backup power–
UPS
Computers
Electronic scanners/Point of sale equipment
Security/Fire alarm systems
Telecommunications

Primary Power–
Portable medical equipment
Robots
Wheelchairs
Photographic equipment

When there's no excuse for failure.

In what is perhaps the most highly publicized "field test" of its kind, six dryfit marine batteries powered the computers onboard the *Stars & Stripes*™ for the yacht's dramatic 1987 America's Cup win! The dryfit Prevailer batteries served as sole source of power for the yacht throughout the Cup races, running not only the computers, but also the all important navigation system and video camera equipment.

The same proven technology that has made dryfit the best selling battery in Europe for decades has been harnessed to meet marine needs and named dryfit Prevailer™. Featuring superior endurance and dependability characteristics, the new marine battery eliminates winter storage problems, can be used and charged at any angle and will even survive an accidental submersion.

AMERICA'S CUP '87
Stars & Stripes
OFFICIAL SUPPLIER

SONNENSCHEIN BATTERIES, INC.
P.O. Box 339
Cheshire, CT 06410
(203) 271-0091

Exclusive Canadian Agent:
DURACELL, INC.
Mississauga

Sonnenschein

Putting us to the test begins with one quick, free call to

1-800-4dryfit

dryfit® and Prevailer™ are trademarks of Sonnenschein Batteries, Inc.

CIRCLE NO 124

122-key adjustable keyboards. Each also buffers as many as 1500 keystrokes and has a printer port that allows you to attach a local screen printer. The monochrome display terminals are Models 078-2 and 180-2. The 078-2 has a 12-in. display and is available with green or amber phosphor; it costs $1295. The 15-in. 180-2 is plug compatible with IBM's 3180-2 and costs $1995. The color display terminals, Models 079-2 and 179-2, each display 7 colors. The 079-2, which sells for $1895, has a 12-in. display. The 179-2 has a 14-in. display and costs $2095. The four printer terminals are Models 201, 851, 214XP, and 225. The 201, a message printer, operates to 220 cps in draft mode and costs $545. The 851 ink-jet printer/terminal prints at as much as 220 cps in draft mode; it costs $775. The 214XP, which can reach 400 cps, sells for $5100. The 225, a plug-compatible replacement for the IBM 5225, prints 800 lines/minute in draft mode and costs $12,800.

Telex Computer Products, 6422 E 41st St, Tulsa, OK 74135. Phone (918) 627-1111.

Circle No 379

VOICE/DATA MUX

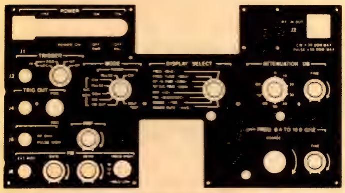
- *Simultaneously transmits voice and data*
- *Uses standard 2-wire, voice-grade cables*

The Linemate 96 Plus multiplexer transmits voice and data information simultaneously over twisted-pair phone lines between terminals and a central computer. The unit contains a full-duplex asynchronous FSK modem capable of operating at bit rates as high as 9600 bps. You can also use the modem at synchronous speeds of 2400, 4800, and 7200 bps by adding an optional interface card. The multiplexer can transmit data over distances as long as 8 mi on unloaded 2-wire cable, and data transfer is completely transparent during normal telephone operation, including dialing, supervisory, and ringing periods. The Linemate 96 Plus is available as a stand-alone desktop unit or as a board-level product. £233.

Trend Datalink Ltd, Knaves Beech Estate, Loudwater, High Wycombe, Bucks HP10 9QE, UK. Phone (06285) 28112. TLX 849408.

Circle No 380

At only .085" thick, our new fiberglass electroluminescent panels are designed to replace lightplates and traditional metal plates that may not presently be illuminated. Our thin .085" panels weigh 40% less than a typical .220" plexiglass panel, and with an expansion coefficient equal to aluminum, the panels are ideal for surface-mount applications.



LSI electroluminescent panel

As the pioneer developers of EL lamps, as well as the process of encapsulation, we have combined the uniform, cool surface illumination of EL with the strength of fiberglass to create a new standard for panels.

Durability and long life luminescence

LSI EL lamps eliminate the need for sockets, bulbs, diffusers or reflectors, and add no heat to the assembly. This, together with their long life and availability in many colors, make them the intelligent choice for panel illumination – far superior to LEDs or incandescent bulbs. We create panels (including standard .220" plexiglass) in almost any shape and size, as well as complex designs with multiple holes and cutouts. Lamps can be filtered to comply to ANVIS or other military specifications, or to your design requirements.

If you'd like a copy of our brochure, or have questions regarding panel applications, just call, write or TWX the LSI Marketing Department.

Luminescent Systems Inc.
Setting the Standard

Tel. (603) 448-3444 TWX 710-366-0607
Etna Rd., Lebanon, NH 03766

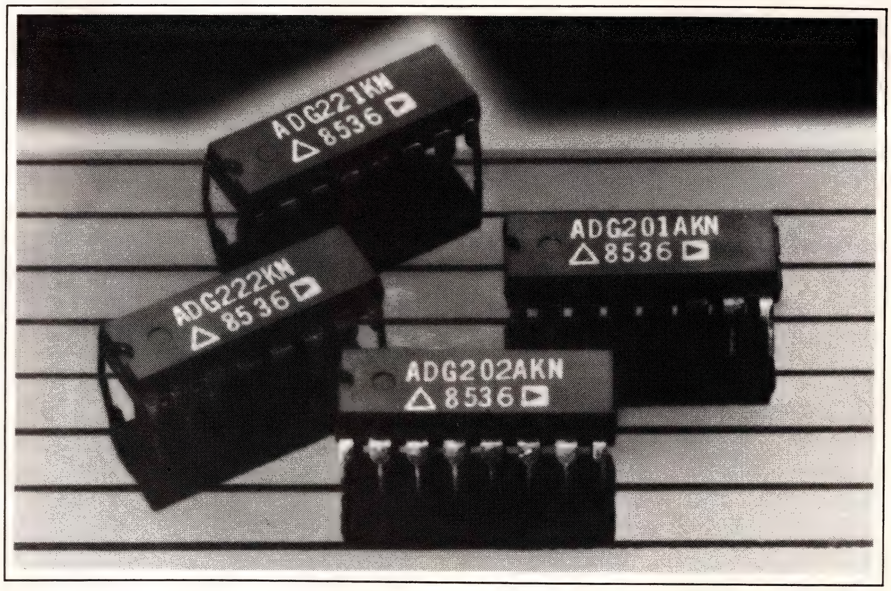
CIRCLE NO 114

NEW PRODUCTS

INTEGRATED CIRCUITS

CMOS SWITCHES

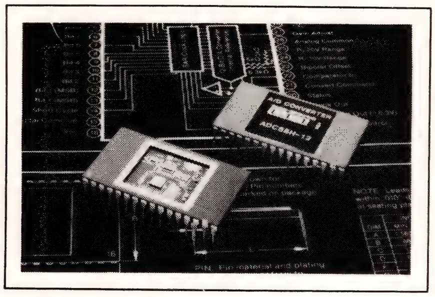
- *Onboard address latches available*
- *Feature a 44V max power-supply rating*



Models ADG201A and ADG202A are quad spst CMOS analog switches that feature a 44V max power-supply rating and typical current leakages of 500 pA. Models ADG221 and ADG222 offer the same leakage and power-supply ratings but also include onboard address latches that simplify the interface to μPs. According to the manufacturer, the ADG222 is the first CMOS switch that closes in response to a logic one at the address input. (The ADG221's switches close when the address level is low.) All switches offer a signal range of ±15V and single-supply (15V) operation. Fabricated with junction-isolated CMOS technology, the devices come in plastic or ceramic DIPs, LCCs, and PLCCs for the commercial, industrial, or military temperature ranges. ADG201A and ADG202A, from $3.15 and $2.95, respectively; ADG221 and ADG222, from $2.56 (100). Allow 12-week delivery for the military version.

Analog Devices Inc, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565. TWX 710-394-6577.

Circle No 381



A/D CONVERTERS

- *Improved versions of industry standards*
- *Offer monolithic D/A-converter chip*

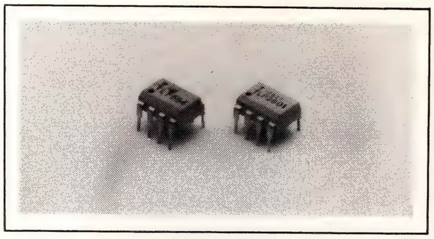
Improved versions of the company's industry-standard ADC84/85 A/D converters feature a monolithic D/A-converter chip and a CMOS gate array. These 12-bit converters offer 50% lower power dissipation (725 mW max) and 15 to 20% lower prices than the company's earlier models. The conversion time is 10 μsec for 12 bits and 6 μsec for 10 bits. Housed in 32-pin hermetic side-brazed DIPs, the converters specify monotonicity for the commercial, industrial, and military operating temperature ranges. The parts provide output data in parallel and serial form and operate from supply voltages of ±12 to ±15V, and 5V. From $62 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

Circle No 382

OPTOCOUPLERS

- *Combine GaAlAs LEDs with high-gain photodetectors*
- *Have open-collector, Schottky-clamped transistor outputs*



The TLP554 and TLP2601 optocouplers combine GaAlAs (gallium aluminum arsenide) infrared LEDs with high-gain photodetectors. The outputs are open-collector, Schottky-clamped transistors. A Faraday shield integrated on the photodetector chip shunts capacitively coupled common-mode noise to ground; the shield provides a common-mode transient immunity of 1000V/μsec by reducing the effect of capacitive coupling between the input LED and the detector. The devices operate over −40 to +85°C. $4.37 (100). Delivery, eight to 10 weeks ARO.

Toshiba America Inc, ECBS, Semiconductor Products Div, 2692 Dow Ave, Tustin, CA 92680. Phone local office.

Circle No 383

A FULL DECK OF STATICS MAKES CENTS

It's no secret Hyundai makes a quality product that passes along substantial user savings. And now — a full line of SRAMs offering you a variety of speeds from 25ns to 150ns — plus the opportunity to reduce system costs.

Volume produced in state-of-the-art CMOS technology with standard DIP packaging, Hyundai's static RAMs will face up to meet all your system needs from fast access times to low power operation.

At Hyundai, we believe in helping you design a winning hand with high performance alternatives that help take the bite out of your budget.

Call one of our sales offices listed below for pricing, literature and samples.

HYUNDAI CMOS SRAMs

Product	Part No.	Orgn.	Access Time (ns)	Packaging
16K SRAM	HY6116	2Kx8	100,120,150	24-pin DIP (600)
16K SRAM	HY61C16A	2Kx8	25,35,45,55,70	24-pin DIP (300/600)
16K SRAM	HY61C67	16Kx1	25,35,45,55,70	20-pin DIP (300)
16K SRAM	HY61C68	4Kx4	25,35,45,55,70	20-pin DIP (300)
16K SRAM	HY61C69	4Kx4	25,35,45,55,70	22-pin DIP (300)
64K SRAM	HY62C64	8Kx8	100,120,150	28-pin DIP (600)
64K SRAM	HY62C64A	8Kx8	35,45,55,70	28-pin DIP (600)
64K SRAM	HY62C87	64Kx1	35,45,55	22-pin DIP (300)
64K SRAM	HY62C88	16Kx4	35,45,55	22-pin DIP (300)
256K SRAM	HY62C256	32Kx8	55,70,90	28-pin DIP (600)

HYUNDAI
SEMICONDUCTOR

• **REGIONAL SALES OFFICES: CALIFORNIA** (408) 986-9800 **ILLINOIS** (312) 860-6406 **MASSACHUSETTS** (617) 239-8015 • **REPRESENTATIVES: ALABAMA/GEORGIA/CAROLINAS/TENNESSEE,** CSR Electronics (404) 396-3720 **ARIZONA,** Sanford Sales (602) 957-3570 **CALIFORNIA,** Straube Associates (415) 969-6060; Wiley Co. (213) 666-1611 **COLORADO/UTAH,** Elcom, Inc. (303) 337-2300 **CONNECTICUT/MASSACHUSETTS,** Gerald Rosen Co. (617) 481-9277 **FLORIDA,** EIR, Inc. (305) 660-9600 **N. ILLINOIS/S. WISCONSIN,** Heartland Technical Marketing (312) 577-9222 **INDIANA/KENTUCKY/MICHIGAN/OHIO/W. PENNSYLVANIA,** Giesting & Associates (513) 385-1105 **IOWA,** J.R. Sales Engineering (319) 393-2232 **KANSAS/S. ILLINOIS/MISSOURI/NEBRASKA,** Advanced Technical Sales (913) 782-8702 **MARYLAND,** Walker-Houck Associates (301) 356-9500 **MINNESOTA/DAKOTAS/N. WISCONSIN,** P.S.I. (612) 944-8545 **NEW YORK,** Phase Four Technical Reps. (516) 482-1790; Labtronics, Inc. (315) 455-7314 **E. PENNSYLVANIA,** Denco Electronic Components (215) 630-8990 **WASHINGTON/OREGON,** Quest Marketing, Inc. (206) 747-9424 **CANADA,** Gidden-Morton Associates, Inc. (416) 671-8111.

CIRCLE NO 132

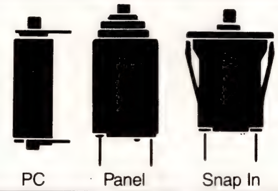
DON'T BLOW IT WITH FUSES

Start with "THE RIGHT STUFF"–

E-T-A CIRCUIT BREAKERS

Blowing a fuse is a small matter but not when it affects your product's performance, causing inconvenience, downtime and replacement costs. E-T-A Circuit Breakers provide dependable protection. These manual reset Circuit Breakers *do eliminate* fuse replacement.

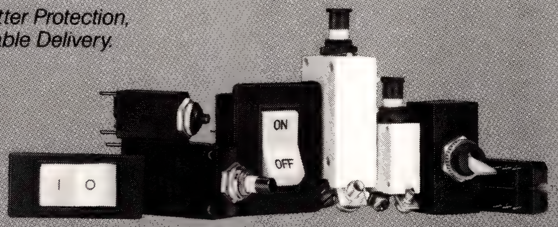
E-T-A has "THE RIGHT STUFF"–it is the same concept as a magnetic circuit breaker. It can handle high inrush currents without nuisance trips. And, it is not shock or vibration sensitive. 100% of E-T-A's Circuit Breakers are calibrated and tested. They not only meet requirements for, but carry UL CSA VDE and other worldwide approvals.



E-T-A Circuit Breakers are available in the various mounting styles shown.

Ideally suited for a wide variety of applications, E-T-A Circuit Breakers are used in equipment such as Data Processing, Medical Instruments, Communication, Power Supplies, Marine and Automotive.

Get all "THE RIGHT STUFF"–Better Protection, Economical Prices and Dependable Delivery. Call (312) 647-8303 or write.



E-T-A®
CIRCUIT
BREAKERS

setting the pace for circuit protection

7400 North Croname Road, Chicago IL 60648
312/647-8303 • TELEX: 253780 • FAX:312/647-7494

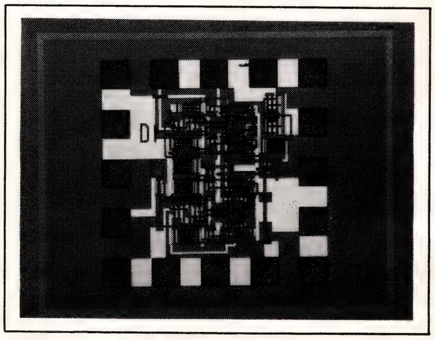
CIRCLE NO 37

DID YOU KNOW?

Half of all EDN's
articles are staff-written.

EDN

INTEGRATED CIRCUITS



GaAs PRESCALER

- *3-GHz, divide-by-4 device*
- *Operates over military and commercial temperature ranges*

The monolithic ADV 3040 is a gallium arsenide, 3-GHz, divide-by-4 prescaler for microwave and high-frequency-synthesizer applications. The device provides ECL-compatible output levels over the range 0.8 to 3 GHz, and it operates over the military and commercial temperature ranges. Specifications include −130-dBc/Hz phase noise, 50Ω input impedance, and a 1.5:1 input VSWR. Single-sideband phase noise at 10 kHz does not contribute to the noise sidebands of a microwave source locked in a wideband phase-locked loop, nor does that phase noise add to the noise floor of a phase-locked signal source when that source uses a 10-MHz crystal as its reference. Commercial-grade version in an 8-pin flat pack, $77 (1000).

Anadigics Inc, 35 Technology Dr, Warren, NJ 07060. Phone (201) 668-5000. TLX 510-600-5741.

Circle No 384

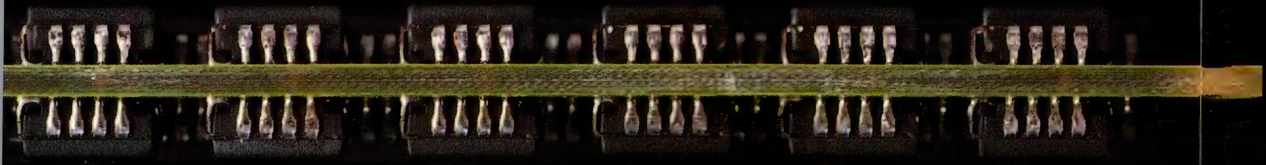
MICROPROCESSOR

- *Accommodates Forth language slice*
- *Operates at clock frequencies to 10 MHz*

The NC6000 μP accommodates the Forth language slice using stack controllers that can access 512 words of external stack memory, and it has six bits of additional stack addressing to function as a process

All our customers could do it years ago

And one of them did. A major producer of MULTIBUS* boards used our SCICARDS® System to design this surface mounted board back in 1984. Since then, all our customers have received six updates of our single version software, including additional enhancements to the SMD capability. So if 70 percent of the Fortune 500 electronics firms want surface mounted technology today, they've got it today. They've got the SCICARDS System. If you'd like to see why the SCICARDS System is the benchmark in the industry for PCB design, write or give us a call. We'll give you a demonstration.



7635 Main Street, Fishers, NY 14453
1-800-4-HARRIS Ext. 4340
1-800-344-2444 (Canada)

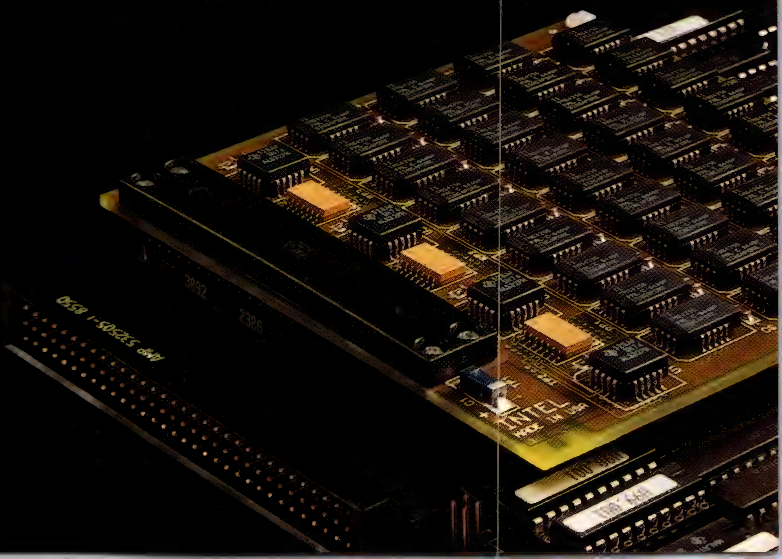
HARRIS

SCIENTIFIC CALCULATIONS

*MULTIBUS is a registered trademark of Intel Corporation.

SCICARDS is a trademark of Scientific Calculations, Inc.

CIRCLE NO 125



If you'd like to bring a sticky packaging problem down to size, call Mepco/Centralab.

We pioneered custom thick film technology in 1943. So we've designed and manufactured hybrid packages for thousands of applications. From computers to telecommunications, automotive to instrumentation, industrial and military.

You'll find us easy to work with, too. We speak your language.

And we have the expertise to ensure the accuracy and space efficiency you need for your design.

At Mepco/Centralab, you'll find the talent and technology you need to make your project a winner. So now, custom hybrids are easy to find. Just give us a call: 1-800-522-7752. In Wisconsin, call (414) 785-6359.

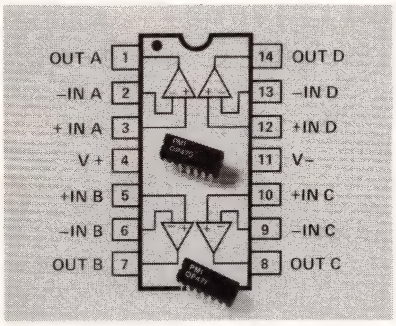
MEPCO/CENTRALAB
A NORTH AMERICAN PHILIPS COMPANY

CIRCLE NO 131

identifier. The μP thus accommodates 64 pages of 512 words on its stacks. Incorporating 6000 gate arrays fabricated from a 2-μm CMOS process, the device operates at clock frequencies as high as 10 MHz. The chip contains no microcode and directly executes the Forth language. Throughput and cycle time are 13 to 16 MIPS and 100 nsec, respectively. Versions in a 121-lead (NC5000) and a 144-lead pin-grid array (NC6000) cost $270 and $340, respectively.

Novix Inc, 19925 Stevens Creek Blvd, Suite 280, Cupertino, CA 95014. Phone (408) 255-2750.

Circle No 385



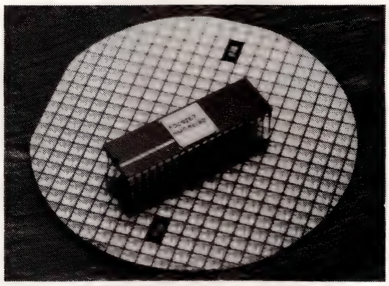
QUAD OP AMP

- *Has voltage noise of 5 nV/$\sqrt{Hz}$ at 1 kHz max*
- *Has 25-nA bias current max*

The OP-470 quad op amp features a low voltage noise of 5 nV/$\sqrt{Hz}$ at 1 kHz max, a 400-μV max input offset voltage, and less than 2-μV/°C input offset drift over the military and industrial temperature ranges. Other specs include a 25-nA max bias current, a 10^6 open-loop gain, 110-dB CMR, a 115-dB PSR, a 2V/μsec slew rate, a 6-MHz gain-bandwidth product, and unity-gain stability. Its 40-pin ceramic DIP conforms to the industry-standard pinout for quad op amps. Industrial grade, $6.50; military grade, $17.90 (100).

Precision Monolithics Inc, Box 58020, Santa Clara, CA 95052. Phone (408) 727-9222. TWX 910-338-0218.

Circle No 386



DISK CONTROLLER IC

- *Comes in 40-pin DIP or 44-lead PLCC*
- *Suitable for use with IBM PC/AT*

The FDC9267 is a monolithic floppy-disk controller IC that's software-compatible with the industry-standard FDC765A. Housed in a 40-pin DIP or 44-lead plastic leaded chip carrier, the FDC9267 is suitable for use with the IBM PC/AT's 1.2M-byte drive, as well as with 3.5-in., 5.25-in., and 8-in. single- or double-sided drives that use single-density (FM) or double-density (MFM) encoding. The device includes all the logic necessary for write precompensation. It also has a self-tuning analog-data separator that eliminates tuning during operation, because an internally derived and filtered error signal controls the voltage-controlled oscillator's center frequency. Plastic-DIP version, $14.95 (100). Delivery, six to eight weeks ARO.

Standard Microsystems Corp, 35 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 273-3100. TWX 510-227-8898.

Circle No 387

DUAL DRIVER IC

- *Drives 2A with 0.6V dropout into resistive or inductive loads*
- *Incorporates alarm outputs to indicate overload conditions*

By incorporating a dc/dc converter to generate a base drive voltage greater than V_{CC}, the two independent emitter output drivers in the UAF1780 high-side switch deliver

REAL TIME HARDWARE

PC-PAL™ PROGRAMMER
The simple, fast and inexpensive way to program PALs in your PC or AT. Works with virtually all 20 and 24 pin devices from MMI, TI and NSC. Includes all the software needed to read, write and verify PALs. Works with JEDEC files and includes a compiler for MMI standard PAL types **$395**

NUMBER SMASHER/ECM™
Triples the speed of CAE and all applications on IBM PC, XT and compatibles!
From **$599**

12 MHz Accelerator Plus A Megabyte for DOS!

***PC Magazine* Editor's Choice**
FastCACHE-286™
Runs the 80286 at 8.5 or 11 MHz and the 80287 at 5, 6 or 11 MHz. Includes 8 kbytes of 55ns CACHE. Compatible with more PCs than any other accelerator, including Leading Edge Model D, Compaq, and Turbo motherboards. Includes 8088 Reboot Switch, DCache and Diagnostics................ From **$449**

Real Time Software

RTOS™ A multi-user, multi-tasking, Real-Time operating system. Includes a configured version of Intel's iRMX-86, LINK-86, LOC-86, LIB-86, OH-86 and MicroWay's 87 DEBUG. Runs on the IBM-PC, XT, PC-AT and COMPAQ **$600**

87 SFL™ Very accurate and fast Scientific Function Libraries. 145 functions: 34 Elementary functions, 18 Probability and Statistical functions, 15 Random Number Generators and many more. Callable from FORTRAN, Pascal, BASIC and C.
First module................. **$250**
Each additional unit......... **$100**

DCACHE™ Disk caching software that speeds up your I/O by storing repetitively used tracks in memory. The amount of memory used can be selected in 64 kbyte banks.... **$49**

MicroWay
P.O. Box 79
Kingston, Mass.
02364 USA
(617) 746-7341

CIRCLE NO 38

Dialight Components. For a complete selection that builds on quality.

Indicator lights, switches, and optoelectronics. Literally millions of Dialight components to choose from. All constructed for the kind of reliability that will do justice to your finished product.

Take Dialight LED circuit board indicators, for example. They're 100% pretested, and feature an easy to mount modular design for reliable, labor-saving board assembly.

Or Dialight readout displays. Complete assemblies ready for instant panel-mounting to save time and money.

Or Dialight switches. Push-buttons, rockers, toggles, levers. Momentary or alternate action. Incandescent, LED, or neon illumination. Hot stamped or engraved graphics. In a wide selection of terminations, contact ratings and mounting styles. Even sealed switches you can solder and wash with other components to reduce assembly costs.

Then there's Dialight indicator lights. Incandescent, LED or neon light sources available in a wide range of sizes and configurations. They'll meet just about any application requirement including military specs. In fact, we've developed over a million different indicator light designs to become the world's largest manufacturer.

Call us today at (201) 223-9400, or write Dialight Corporation, 1913 Atlantic Ave., Manasquan, NJ 08736. If you can't find what you need in our free catalogs, we'll design it for you. So whatever it is you're building, you can build on quality. With Dialight components.

DIALIGHT CORPORATION

Dialight • Kulka • HHSmith

A North American Philips Company

For indicator lights circle 1 For switches circle 40 For optoelectronics circle 79 as much as 2A into their loads with a dropout voltage of 0.6V typ (0.7V max). The dc/dc converter requires one inductor (typically 100 μH) and one capacitor (typically 47 μF or greater) to operate. Both output stages incorporate adjustable current limiting, thermal overload protection, and desaturation monitoring circuitry, which detects overloads and short circuits. The outputs turn off, and an open-collector alarm output is activated, in the event of prolonged output desaturation or excessive power dissipation. A reset input reactivates the drivers, and a strobe input simultaneously switches off both outputs. A reference-voltage input allows you to set the threshold voltage of the reset, strobe, and channel control inputs. The UAF1780 operates from 8 to 32V over −40 to +85°C. In a 16-pin plastic DIP, approximately $11; 15-pin Multiwatt SIP, approximately, $15 (100).

Thomson Semiconducteurs, 45 ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 240780.

Circle No 388

Thomson Components-Mostek Corp, 1310 Electronics Dr, Carrollton, Texas 75006. Phone (214) 466-6000.

Circle No 389

CTCSS CODEC

- *Generates 38 programmable CTCSS subaudible tones*
- *Has parallel and serial interfaces for μP control*

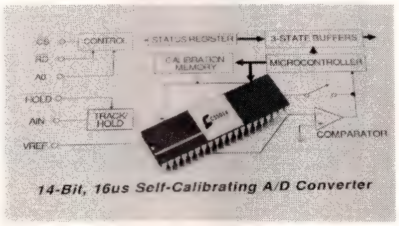
Targeted for use in radio-communication systems, the FX365 CTCSS (continuous tone controlled squelch system) encoder/decoder features a μP interface that allows you to generate, encode, and decode 38 subaudible tones between 67 and 250 Hz. In addition, the μP interface allows you to switch between transmit and receive modes, and to override the tone-decoding circuitry so that you can monitor a received audio signal. The μP interface operates in parallel or serial mode. In the parallel mode, a latch-enable input loads control data into an internal latch; in the serial mode, you can load control data via a serial port and clock inputs. The IC has an on-chip highpass filter with a 300-Hz cutoff frequency, which you can switch into the transmit or receive signal path, to provide audio prefiltering or rejection of the received CTCSS tones, respectively. The FX365 operates from a 5V supply and draws 3.5 mA typ. On-chip clock circuitry generates all frequency timing from a 1-MHz crystal or an external clock source. The device is available in a 24-pin DIP or in a 24- or 28-pin surface-mount package. Approximately £7.75 (1000).

Consumer Microcircuits Ltd, Wheaton Rd, Industrial Estate East, Witham, Essex CM8 3TD, UK. Phone (0376) 513833. TLX 99382.

Circle No 390

Mx-Com Inc, 4800 Bethania Station Rd, Winston-Salem, NC 27105. Phone (919) 744-5050.

Circle No 391

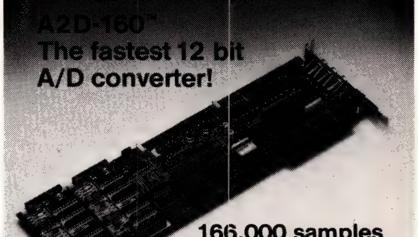


14-Bit, 16us Self-Calibrating A/D Converter

A/D CONVERTER

- *Self-calibrating device*
- *Offers 14-bit absolute accuracy*

The CS5014 is a self-calibrating, 14-bit A/D converter that maintains 14-bit absolute accuracy over time and temperature without external calibration—that is, the nonlinearity error remains within 0.5 LSB, with no missing output codes. The chip has a track-and-hold input, 3-state output buffers, digitally selectable unipolar and bipolar input ranges, and an 8-bit status register



REAL TIME DATA ACQUISITION
For the IBM PC, XT and compatibles

A2D-160™
The fastest 12 bit A/D converter!

166,000 samples per second

Includes Pseudo Random Noise Generator/DAC. For the IBM-PC, XT and AT.................... **$1,295**

AFM-50™ Programmable, low pass filter module for signal conditioning.......................... **$225**

TransVIEW™ A menu driven FFT spectrum/transfer analyzer which takes advantage of the special features of A2D-160. TransVIEW's commands emulate Microsoft Word for easy learning and a minimum of keystrokes................... **$250**

Data Analysis & Controls Software

DAL™ Data Analysis Language. A new scientific/engineering design and analysis software package. Performs matrix, statistical and data analysis along with signal processing and digital filter design... **$395**

CONTROL-X™ Controls Analysis & Design Language. This systems language is a superset of DAL specifically intended for Systems Control Design. It offers the same features as VAX Controls language at 1/20 the price!.................... **$595**

87FFT™ Written in assembly language, 87FFT performs forward and inverse FFTs on real and complex arrays occupying up to 512K of RAM. Callable from most 8087 compatible compilers. The fastest PC FFT package available!...... **$200**

87FFT-2™ For two dimensional FFTs......................... **$100**

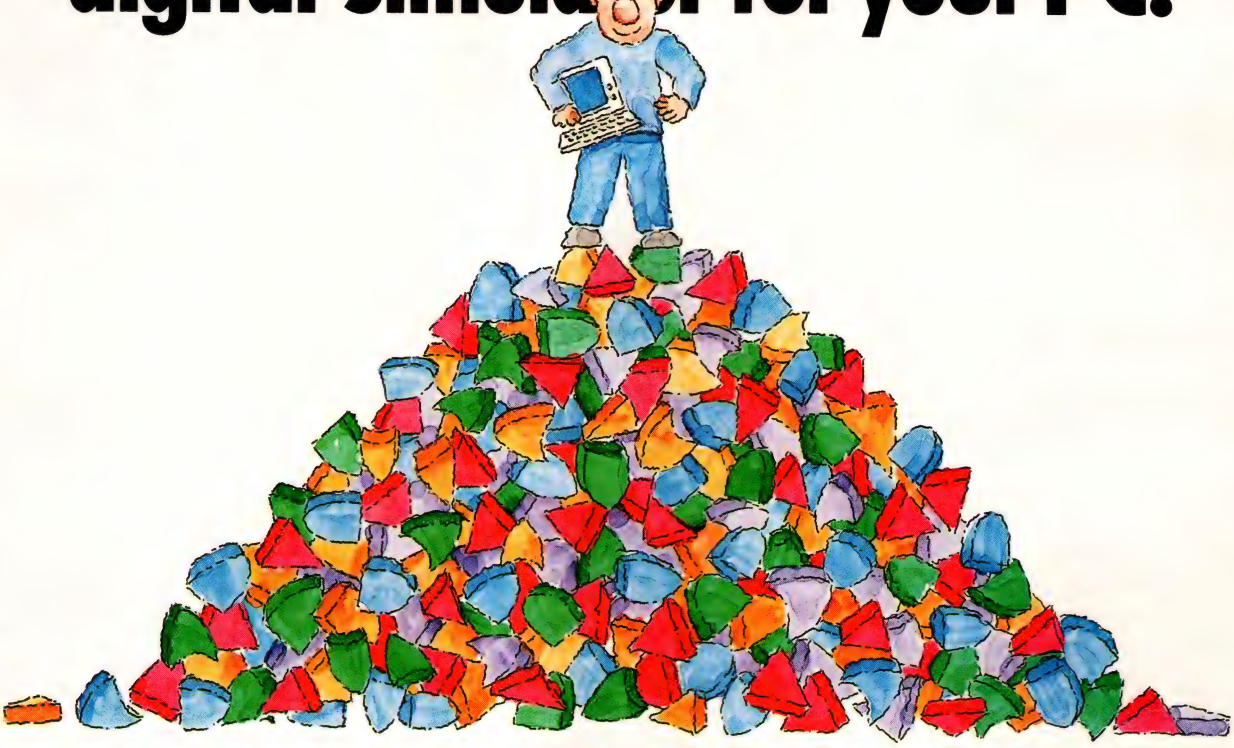
LABTECH NOTEBOOK™ A menu driven, Real-Time data control system. Does analysis, display and streaming to disk of data from A/D boards...................... **$745**

UNKELSCOPE™ Turns your A2D-160 into a digital oscilloscope and data-logger............. **$549**

Micro Way
P.O. Box 79
Kingston, Mass.
02364 USA
(617) 746-7341

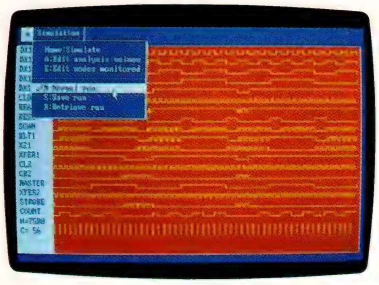
CIRCLE NO 77

MICRO-LOGIC II.™
The CAE tool with a 10,000-gate digital simulator for your PC.



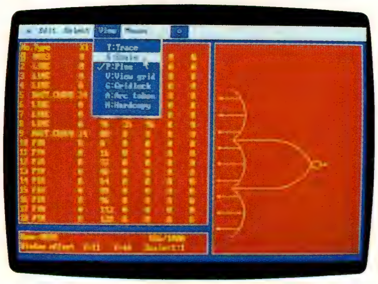
Spectrum Software's MICRO-LOGIC II® puts you on top of the most complex logic design problems. With a powerful total capacity of 10,000 gates, MICRO-LOGIC II helps engineers tackle tough design and simulation problems right at their PCs.

MICRO-LOGIC II, which is based on our original MICRO-LOGIC software, is a field-proven, second-generation program. It has a high-speed event-driven simulator which is significantly faster than the earlier version.



Timing Simulator

The program provides you with a top-notch interactive drawing and analysis environment. You can create logic diagrams of up to 64 pages with ease. The software features a sophisticated schematic editor with pan and zoom capabilities.

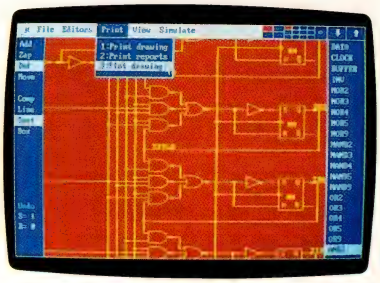


Shape Editor

A 200-type library of standard parts is at your fingertips. And for a new high in flexibility, a built-in shape editor lets you create unique or custom shapes.

MICRO-LOGIC II is available for the IBM® PC. It is CGA, EGA, and Hercules® compatible and costs only $895 complete. An evaluation version is available for $100. Call or write today for our free brochure and demo disk. We'd like to put you in touch with a top digital solution.

- Total capacity of 10,000 gates
- Integrated schematic editor
- Fast assembly language routines
- Standard parts library of 200 types
- Event-driven timing simulator
- Built-in shape editor
- Multiple delay models
- Printer and plotter hard copy



Schematic Editor

spectrum

1021 S. Wolfe Road, Dept. E
Sunnyvale, CA 94087
(408) 738-4387

MICRO-LOGIC II is a registered trademark of Spectrum Software.

Hercules is a registered trademark of Hercules Computer Technology

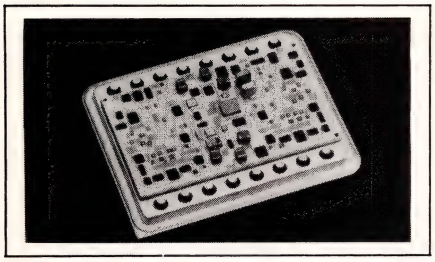
IBM is a registered trademark of International Business Machines, Inc.

CIRCLE NO 130

that contains conversion and calibration information. The typical power dissipation is 150 mW. The ADC comes in a 40-pin DIP and is available in 16- and 32-μsec conversion-time versions that are specified for the commercial, industrial, and military temperature ranges. CDB5014 evaluation board including socketed CS5014, $200. CS5014, from $45 (100).

Crystal Semiconductor Corp, Box 17847, Austin, TX 78760. Phone (512) 445-7222. TWX 910-874-1352.

Circle No 392



DUAL LINE DRIVER

- *Exceeds specs of MIL-STD-188-114A for Type III*
- *Available in a 16-pin, sealed DIP*

Model CSH-192 is a hybrid, dual-channel line driver that exceeds the enhanced performance requirements of MIL-STD-188-114A for Type III devices. The part, housed in a 16-pin, hermetically sealed DIP, includes 3-state, TTL- and ECL-compatible outputs, whose drive capability (25 mA min) is suitable for driving balanced lines such as twisted pairs, coaxial cable, or parallel-wire transmission lines. Output rise and fall times (10 nsec) and propagation delay (35 nsec) allow transmission rates to 10M bps. The driver requires ±5V, 1.76W max. MIL-STD-883B versions are also available. $195 (100). Delivery, 8 to 10 weeks ARO.

Leach Corp, Control Products Div, 6900 Orangethorpe Ave, Buena Park, CA 90620. Phone (714) 739-0770. TWX 910-596-2867.

Circle No 393

SATELLITE TV IC

- *Decodes D2-MAC/Packet standard satellite transmissions*
- *Handles multiple sound channels and data services*

When used in conjunction with other ICs in the Digit-2000 digital-TV chip set, the DMA 2270 D2-MAC decoder IC forms a high-quality, multistandard direct-broadcast-satellite (DBS) TV decoder. It also suits cable-TV applications. The DMA 2270 accepts a digitized baseband signal and includes circuitry for video clamping, automatic gain control, and phase locking of the system clock to the D2-MAC transmission. It also includes luma and chroma stores to regenerate a 13.5-MHz luminance signal and a 6.75-MHz color-difference signal; a contrast multiplier; a color-saturation multiplier; a sync and blanking pulse generator; and a sound decoder and demultiplexer. The device, which is housed in a 68-pin plastic LCC, also handles multiple sound channels and data services. It's software controlled via an IM Bus interface. The chip set, including the DMA 2270 and the four other Digit-2000 devices necessary to build a stand-alone D2-MAC decoder, costs approximately DM 200 (OEM qty).

ITT-Intermetall, Hans-Bunte-Strasse 19, 7800 Freiburg, West Germany. Phone (0761) 517337. TLX 772715.

Circle No 394

CMOS PALs

- *Have mask-programmable architecture*
- *Draw 100 μA max in standby mode*

The ZHAL20A and ZHAL24A Series programmable-logic circuits draw 100 μA max in standby mode and 3 mA/MHz while active. These 35 ZHAL (zero-power hard array logic) devices can implement most of the current 20- and 24-pin PAL/HAL (hand-wired array logic) cir-

REAL TIME SERVICE

For five years, **MicroWay** has been the leader in 8087 support and accelerator board technology. People continue to buy our products for two reasons: one, they work and two, we support our products with one of the best technical support teams in the industry. Join those who know! Buy your 8087 support from **MicroWay.**

287 TurboPLUS™
Speeds up your IBM AT!

An adjustable oscillator lets you increase your AT's 80286 speed in .5 MHz increments. Includes a 10 or 12 MHz 80287 clock and a system reset button.

Board only.................. **$149**
With 80287-10 .... **$549**
With 80287-12 .... **$629**
Optional 80286-10 .... **$175**

8087 Upgrades

8087	5 MHz	**$114**
8087-2	8 MHz	**$149**
80287-3	5 MHz	**$179**
80287-6	6 MHz	**$199**
80287-8	8 MHz	**$259**
80287-10	10 MHz	**$395**
NEC V20-8	8 MHz	**$16**
NEC V30-10	10 MHz	**$30**
64K RAM set	150 ns	**$10**
256K RAM set	150 ns	**$27**
256K RAM set	120 ns	**$39**
128K RAM set	PC AT	**$49**

8087 Software

87 BASIC™ A patch to the IBM Basic or MS QuickBASIC compiler that provides fast, USER TRANSPARENT 8087 support **$150**

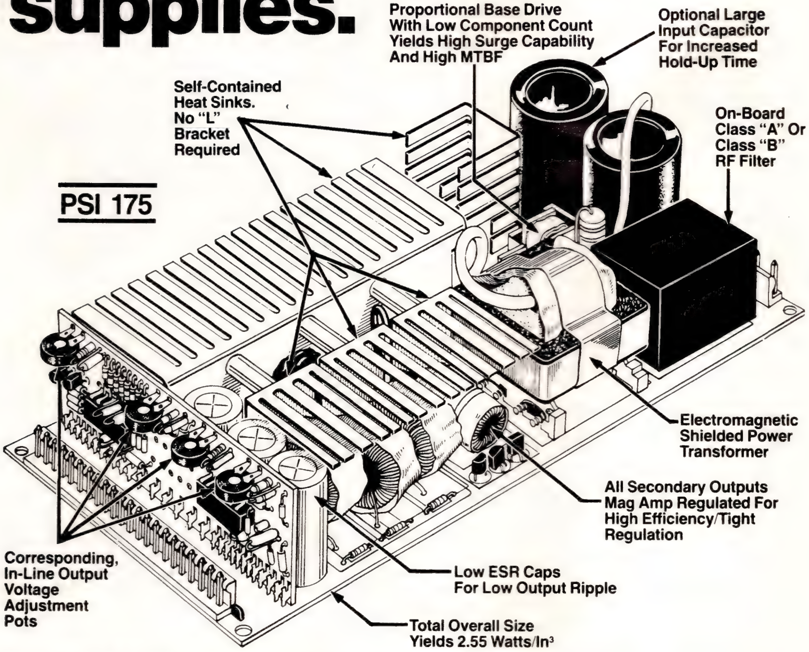
MATRIXPAK™ A run-time package written in assembly language which accurately manipulates large matrices at very fast speeds. Includes matrix inversion and the solution of simultaneous linear equations. Callable from RM, IBM or MS FORTRAN, MS Assembler or 87 BASIC...................... **$99**

87 Verify™ For users that have to be absolutely sure of their results! This background task periodically performs an 8087 accuracy and stress test..................... **$49**

Micro Way
P.O. Box 79
Kingston, Mass.
02364 USA
(617) 746-7341

CIRCLE NO 116

PSI/STD...
Reconsider your concept of standard vs. custom power supplies.


Proportional Base Drive With Low Component Count Yields High Surge Capability And High MTBF
Optional Large Input Capacitor For Increased Hold-Up Time
Self-Contained Heat Sinks. No "L" Bracket Required
On-Board Class "A" Or Class "B" RF Filter
PSI 175
Electromagnetic Shielded Power Transformer
All Secondary Outputs Mag Amp Regulated For High Efficiency/Tight Regulation
Low ESR Caps For Low Output Ripple
Corresponding, In-Line Output Voltage Adjustment Pots
Total Overall Size Yields 2.55 Watts/In³

Now The Choice is Really Yours.

PSI 175 . . . A significant advance in fully configured, multiple-output switching power supplies. And the versatility of the standard PSI 175 module with its available options enables you to obtain a "custom" power supply without the lead time or development costs associated with custom products.

PSI 175 . . . the 175-watt, convection-cooled, quad output power supply. Standard features with many applications: 115/230 VAC, 47-440 Hz, full power rating at 50°C . . . all in the smallest package available. Up to four fully regulated voltage combinations on all outputs. L- brackets for special mounting, and autoranging on input available, plus many other options.

If you previously required custom power supplies, it's time for you to reconsider your concept of standard switchers and specify PSI 175. And remember, if we're unable to meet your needs with a standard unit, we will do a custom design.

Write us today for detailed specifications, complete options, and prices.

Power Systems, Inc.

45 Griffin Road South, Bloomfield, CT 06002
(203) 726-1300 TWX: 710-425-8778
Fax: (203) 726-1495

CIRCLE NO 39

DID YOU KNOW?

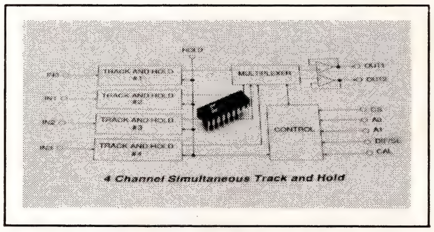
EDN serves
electronic engineers and
engineering managers in more than
100 countries worldwide.

EDN

cuits. The ZHAL option in the company's PALASM2 software can confirm whether a design specification will fit the ZHAL architecture. For a minimum of 5000 devices and a $4000 nonrecurring engineering charge, unit prices are $2.52 for ZHAL20A Series and $4.25 for ZHAL24A Series. Production, eight to 10 weeks after design approval.

Monolithic Memories Inc, 2175 Mission College Blvd, Santa Clara, CA 95054. Phone (408) 970-9700. TWX 910-338-2376.

Circle No 395



QUAD TRACK/HOLD IC

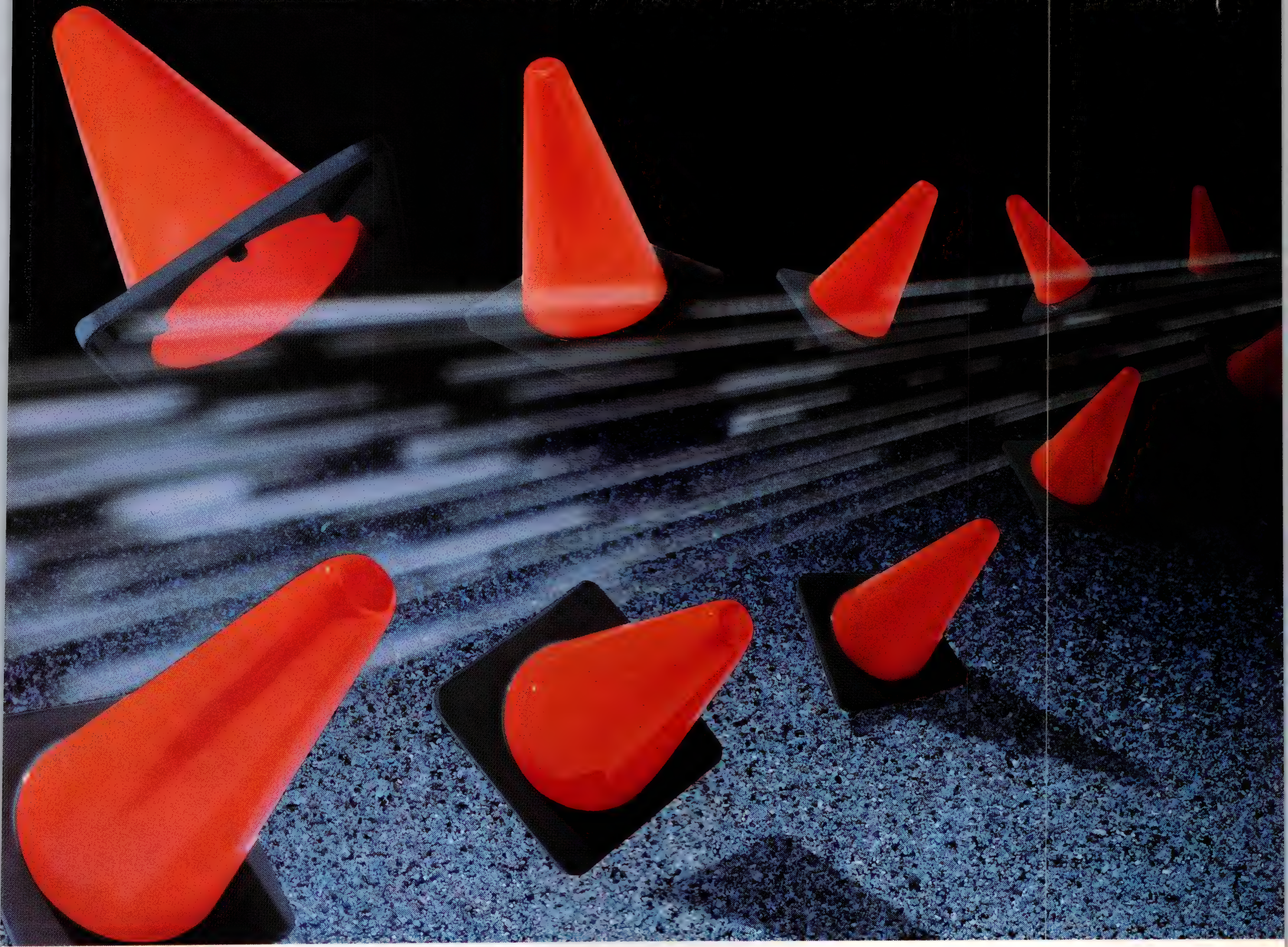
- *Has 12-bit accuracy*
- *Each track/hold amplifier includes a hold capacitor*

The Model CS31412 is a monolithic quad track/hold IC that offers 12-bit accuracy and a 1-μsec acquisition time. You can configure the input multiplexer to accept four single-ended signals or two differential signals. Each of the IC's four track/hold amplifiers includes a hold capacitor; the voltage droop is only 0.01 μV/μsec. The device also includes a RAM-based calibration scheme that reduces the total unadjusted error—including nonlinearity, gain error, and hold-pedestal error—to 700 μV max over time and temperature. The CS31412 comes in an 18-pin ceramic DIP, operates on ±5V supplies, and dissipates 250 mW. To simplify its evaluation, you can buy the CDB31412 demo board, including a socketed IC, for $100. CS31412, from $36 (100).

Crystal Semiconductor Corp, Box 17847, Austin, TX 78760. Phone (512) 445-7222.

Circle No 396

Introducing the Fastest Family of CMOS EPROMs on the Circuit



WSI EPROMs: Twice as fast as the Pack.
WSI's family of CMOS EPROMs keeps you in the fast lane with access times as low as 55 NS, leaving systems with wait states in the dust. That means you can now turbo charge your system. With EPROM architectures ranging from 8K x 8 to 16K x 16.

WSI RPROMs: Bipolar speed with CMOS low power.
Our unique CMOS high-density Reprogrammable PROMs (RPROMs) match the speed of your favorite bipolar PROMs. So you can replace them with our pin-out compatible RPROMs. And get EPROM reprogrammability and low power consumption as well.

WSI: Puts you on track fast....... reliably.
Our EPROMs and RPROMs program in less than 16 seconds. Plus you get 200 MA of latch up protection and a minimum of 2000 V of ESD protection. So your production revs up faster. With more reliable, smoother running products.

Call the WSI team today.
With this kind of speed and reliability, it makes sense to check out WSI's EPROMs and RPROMs.

So call us at **(800) 331-1030**, ext. 234, or in CA. **(800) 323-3939**, ext. 234. And we'll get you on the road to higher performance today.

Waferscale Integration, Inc.,
47280 Kato Road, Fremont,
CA 94538

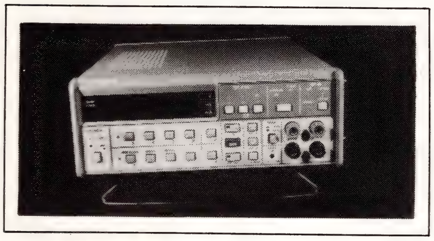
Part No.	Speed	Type
WS57C191/291	40 ns.	2k x 8 CMOS RPROM
WS57C43	55 ns.	4k x 8 CMOS RPROM
WS57C49	55 ns.	8k x 8 CMOS RPROM
WS57C64F	55 ns.	8k X 8 CMOS EPROM
WS57C128F	70 ns.	16k x 8 CMOS EPROM
WS57C256F	70 ns.	32k x 8 CMOS EPROM
WS57C65	55 ns.	4k x 16 CMOS EPROM
WS57C257	70 ns.	16k x 16 CMOS EPROM

WaferScale
INTEGRATION, INC.

CIRCLE NO 129

NEW PRODUCTS

TEST & MEASUREMENT INSTRUMENTS



CALIBRATOR

- *Executes 160-step voltage-current program*
- *Sources 0 to ±12V at 0 to ±120 mA*

The 6142 programmable dc voltage-current generator can source 0 to ±11.999V at as much as ±119.99 mA in 0.1-µA steps. Its accuracy ratings are (±0.035%)+(±5 µV) and (±0.035%)+(±0.3 µA). The instrument has a 160-step nonvolatile program memory. The unit is completely programmable over the IEEE-488 bus. $3995.

PrimeLine, Box 670, San Fernando, CA 91341. Phone (800) 525-5554; in CA, (818) 764-5400. TLX 4943094.

Circle No 397

80386 EMULATOR

- *Runs at 16 MHz*
- *Lets you set breakpoints on task switches*

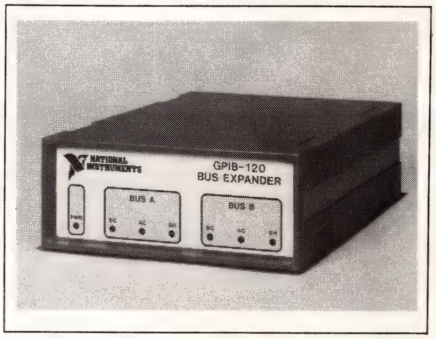
The Model ICE-386 emulator comes in an IBM PC/AT DOS-based version and a Xenix-based version. It contains a bond-out version of the 80386 µP that is not available on the open market. The emulator runs at clock speeds to 16 MHz. It has 128k bytes of emulation memory, which is mappable in 4k-byte increments. In addition to having the standard emulator breakpoints, the unit can break on task switches and illegal data accesses. It can store 2000 frames of program execution along with time tags. The company claims that its emulator's timing and electrical specs are exactly equivalent to those of the target µP. ICE-386, $15,000; Xenix-to-DOS field upgrade, $1100.

Intel Corp, Literature Dept W342, 3065 Bowers Ave, Santa Clara, CA 95051. Phone local office.

Circle No 398

IEEE-488 EXTENDER

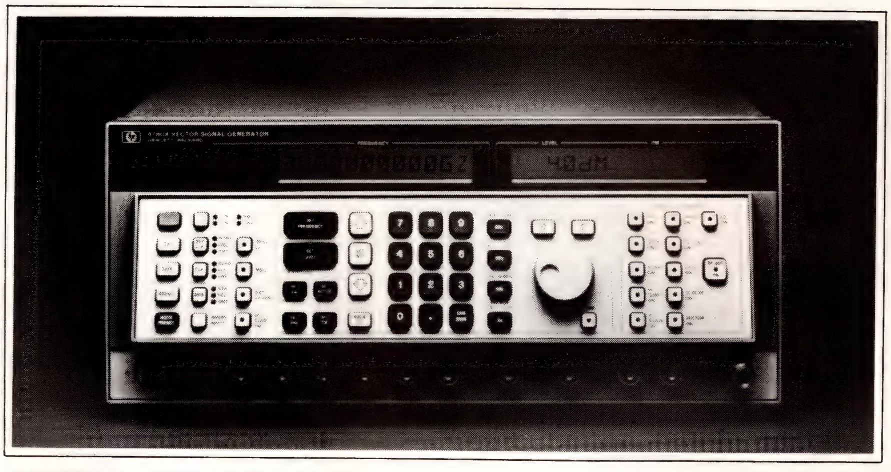
- *Extends possible length of cable by 18m*
- *Permits attachment of 14 extra devices*



The GPIB-120 IEEE-488 bus extender allows you to extend your total cable length from 20 to 38m. Furthermore, you can add 14 more devices to the bus. The extender has no switches for you to set; it detects the addresses of controllers, talkers, and listeners, and it configures itself. The unit operates transparently and requires no modifications to your software. $995.

National Instruments, 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488. TLX 756737.

Circle No 399



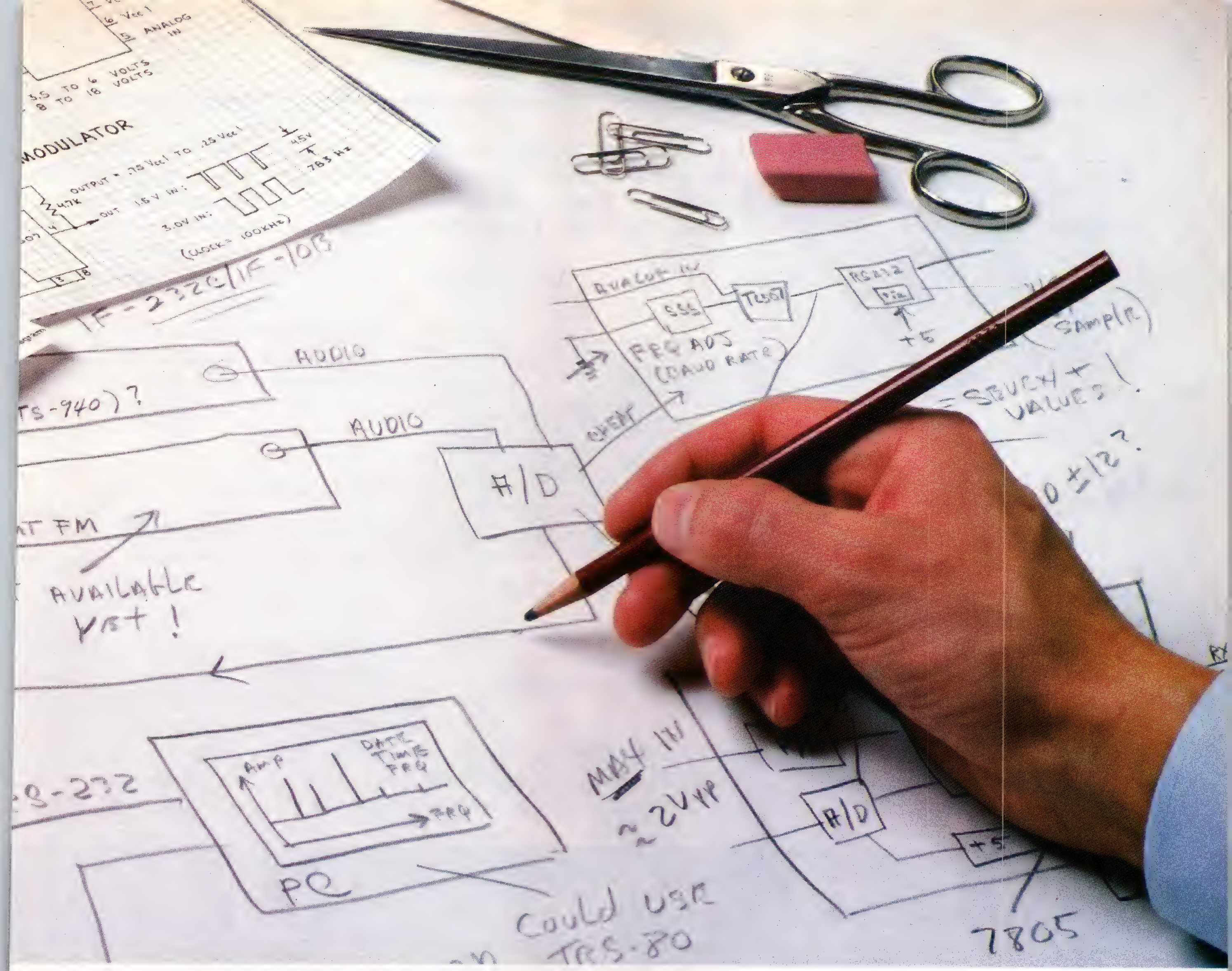
VECTOR GENERATOR

- *Uses both digital and analog modulation signals*
- *Processes in-phase and quadrature modulation inputs*

The Model HP 8780A vector signal generator accepts both digital bit streams and conventional analog signals as modulation inputs. Its clock rates range from dc to 150 MHz in clocked mode and from dc to 50 MHz in asynchronous mode. The instrument has a frequency range of 10 MHz to 3 GHz. The generator also processes in-phase and quadrature analog modulation signals ranging from dc to 350 MHz. In addition, you can amplitude-modulate the output with a scalar (nonvector), 500-kHz AM signal or a 50-MHz (p-p) FM signal. The generator's synthesized carrier has a resolution of 1 Hz. Its output spans +10 to −100 dBm. $55,000. Delivery, 12 weeks ARO.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 400



VideoLog gives you more time to do what you do best.

If you're an engineer, it can take you a half day, or more, to hunt through a mountain of data books and catalogs for the components you need. And even then, there's no guarantee that what you find is the best solution to your problem.

Now there's a better way to locate components. VideoLog.

From an enormous online database, covering a broad spectrum of over 650,000 commercial and military semiconductors and other products, you can find what you need in an average of 15 minutes. You can locate a new component, or an alternate source. You'll find out who makes it, what it costs, and where you can get it. You'll also know if the device is still current, or if a replacement exists.

VideoLog is fast, convenient, it keeps you abreast of new product news and industry developments. But, most importantly, it gives you more time to do the things you do best.

VideoLog®

It's there when you need it.

VideoLog Communications, 50 Washington Street, Norwalk, CT. 06854

For more information, call

1-800-VIDEOLOG

(1-800-843-3656). In Conn.: (203) 838-5100. Or use the coupon below.

Free Online Demo:

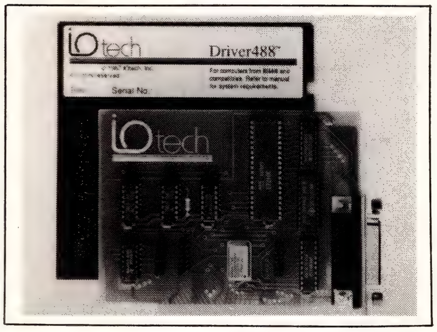
Dial 1-800-VIDPEEK, (1-800-843-7335) with any ASCII (80 col.) terminal and 300 or 1200 baud modem (even parity, 7 data bits, 1 stop bit). In CT, call 203-852-1239.

Please send more information about VideoLog.

EDN DE 318

Name__________
Title__________ Mail Stop__________
Company__________
Address__________
City__________
State__________ Zip__________
Telephone (______)__________
Area Code

CIRCLE NO 126



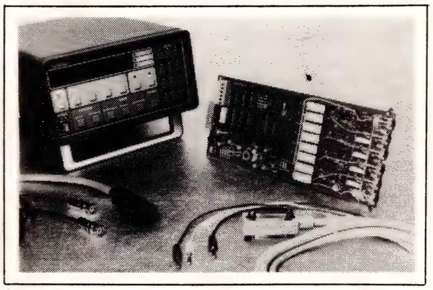
IEEE-488 PACKAGE

- *Runs on an IBM PC*
- *Works with high-level languages*

The Personal488 hardware and software package comprises an IEEE-488 board that plugs into an IBM PC, and software for that board. The package requires no language-specific device drivers or routines; the board's control software becomes part of the PC's DOS. The package's commands are similar to those of HP's Series 80 controllers. The board automatically reports errors and can perform DMA as fast as 400k bytes/sec. $395.

IOtech Inc, 23400 Aurora Rd, Cleveland, OH 44146. Phone (216) 439-4091.

Circle No 401



HALL-EFFECT OPTION

- *Hall-effect option plugs into company's scanner*
- *Measures charge carriers in wafer*

Model 7065 is a Hall-effect pc board that plugs into the company's Model 705 or 706 scanners. The board measures the mobility and concentration of charge carriers in a semiconductor wafer. The card can measure high- or low-resistivity wafers. It can measure sample resistances to $10^{12}\Omega$ and Hall-effect voltages as low as 50 nV. $4995.

Keithley Instruments Inc, 28775 Aurora Rd, Solon, OH 44139. Phone (216) 248-0400. TLX 985469.

Circle No 402

SOFTWARE ANALYZER

- *Combines μP development system, software analysis*
- *Tallies and times software events in real time*

The OptiLab Microprocessor Development Toolbox integrates the company's emulator and bus analyzer with software-performance analysis. The ROM emulator works with more than 150 μPs. When analyzing software performance, you can

It's traditional to charge more for a fast-ship enclosure.

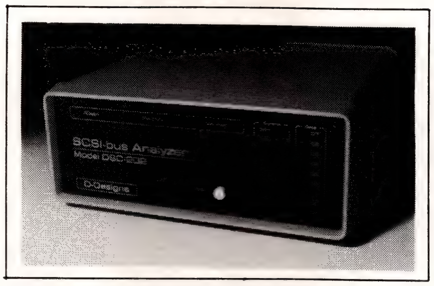
count and time-tag software events in real time at full speed. The software displays the results of the performance analysis on the screen of an IBM PC (you need a PC both to control the emulator and to run the software). The 32k-byte version costs $5980.

Orion Instruments Inc, 702 Marshall St, Redwood City, CA 94063. Phone (415) 361-8883. TLX 530942.

Circle No 403

SCSI ANALYZER

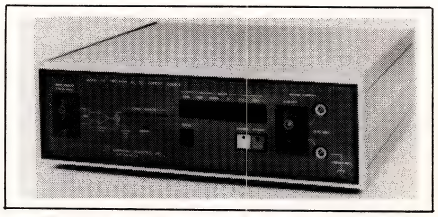
- *Records transactions in transitional-timing mode*
- *Options enable unit to emulate SCSI device*



The DSC-202 is a SCSI bus analyzer. It also offers the option of emulating a SCSI device. The analyzer requires a dumb terminal or an IBM PC for control. It stores as many as 8000 bus transactions in the transitional-timing mode. An optional time stamp provides 50-nsec timing resolution. In addition to 56 SCSI bus signals, the analyzer can record as many as eight additional inputs. The unit meets ANSI X3T9.2 specifications and can transfer data at rates as high as 1.5M bps. The unit has a 2k-byte EEPROM and 7k bytes of static RAM for setups and user programs. DSC-202, $4950; emulator and time-stamp option, $1900; if ordered together, $6500. Delivery, 60 days ARO.

D-Designs, Box 1141, Palo Alto, CA 94301. Phone (415) 327-1525.

Circle No 404



CURRENT SOURCES

- *Units provide 1 kW*
- *Have 50-μsec/V slew rate*

The C Series comprises three ac/dc current sources that supply 100A at 10V, 50A at 20V, or 20A at 50V. The 5¼-in., rack-mounted units require a 0 to 20V input stimulus. The units' slew rate is 50 μsec/V. Their input bandwidth is 10 kHz, and their basic output-current accuracy is 0.005%. The sources are IEEE-488 compatible. $4550. Delivery, stock to 60 days.

Shepherd Scientific Inc, 7918 Convoy Ct, San Diego, CA 92111. Phone (619) 268-9696.

Circle No 405

Optima just broke with tradition.

Sure, you want enclosures fast. For prototypes or short runs.
But traditionally, a fast-ship enclosure usually means the faster they ship, the more you pay.
No longer. Presenting Instant Optima. Enclosures famous for quality and looks, shipped in just three days at our low, regular pricing.
And thanks to our newly expanded Instant Optima line, you get more choices and color combinations than ever. From vertical cabinets to instrument cases. Even EMI/RFI shielded cabinets and our versatile new packaging concept: MPS (Modular Packaging System). All pre-assembled and ready to use.

Instant Optima. The beginning of a new tradition.
For instant service and our new catalogue, call our hotline at (404) 496-4030. Optima Enclosures, 2166 Mountain Industrial Blvd., Tucker, GA 30084-5088. FAX: 404-496-4041.

OPTIMA®
ENCLOSURES
Gichner Systems Group
A Division of The Union Corporation
CIRCLE NO 50

© 1987 Optima Enclosures

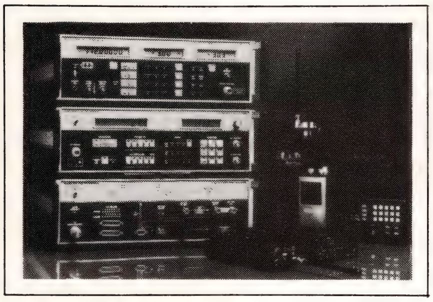
ANALYZER

- *Records line-to-line and line-to-neutral power disturbances*
- *Has built-in printer*

Model 646-3 is a 3-phase power-line-disturbance analyzer that reports voltage disturbances. It records voltage sags, voltage surges, impulses, and undervoltage and overvoltage conditions. It also recodes frequency variations. The unit monitors both line-to-line and line-to-neutral disturbances. Its built-in printer prints a record of each disturbance. The unit has a separate dc input. A temperature probe is optional. $3690.

Dranetz Technologies Inc, Box 4019, Edison, NJ 08818. Phone (201) 287-3680.

Circle No 406



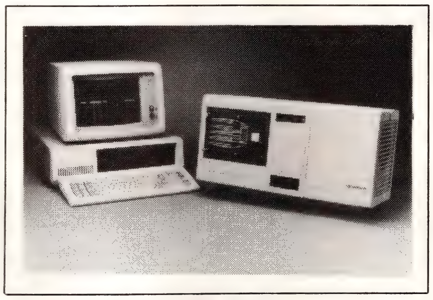
RADIO TESTERS

- *Check 2-way transceivers semiautomatically*
- *Controller software is written in Basic*

The MISATT semiautomatic test sets take routine measurements on AM or FM transceivers. The sets contain three IEEE-488 instruments: a 2019A or 2018A AM/FM signal generator, a 2305 automatic modulation meter, and a 2306 programmable interface unit. The software supplied with the sets is written in Basic, so you can expand or modify the test routines. The software runs on Hewlett-Packard controllers. The test routines include sensitivity, sinad ratio, power, frequency, and modulation tests. Adding a 2017 signal generator enables you to perform extended tests, such as adjacent-channel and image- and IF-rejection tests. Basic system (without controller), $25,000. Delivery, 60 to 90 days ARO.

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401. Phone (800) 233-2955; in NJ, (201) 934-9050.

Circle No 407



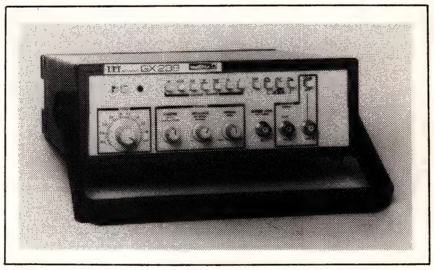
ASIC VERIFIER

- *Tester verifies 190-pin, 20-MHz ASICs*
- *Lets you program test patterns in 1-nsec increments*

The Logic Master ST is a modular benchtop tester for verifying ASICs. The unit can handle chips having as many as 190 pins. The unit can perform real-time pattern generation, data acquisition, and pattern matching at clock speeds as high as 20 MHz. You can program its pattern-generation channels' leading edges in 1-nsec increments in either NRZ or DNRZ formats. The pattern generator has branching, looping, and ASIC-initialization capabilities. The unit can use an IBM PC for control. You can download test patterns from common CAE systems and edit the patterns in real time on the PC. You wire replaceable front-panel cards to accommodate different devices. The 32-channel version is $16,800; a typical configuration for 100-pin devices costs around $40,000.

Integrated Measurement Systems Inc, 9525 SW Gemini Dr, Beaverton, OR 97005. Phone (503) 626-7117.

Circle No 408



FUNCTION GENERATOR

- *Covers the frequency range of 0.2 Hz to 2 MHz*
- *Has external-sweep frequency control*

The GX239 function generator provides sine-, square-, and triangular-wave outputs, plus dc and pulsed TTL-level outputs. The instrument has seven decade-frequency ranges, which allow you to select output frequencies between 0.2 Hz and 2 MHz. Its frequency accuracy is ±5% of range, and its sine-wave distortion below 200 kHz is <1%. You can adjust the output waveform's duty cycle between 20 and 80%, and you can vary the output level into an open circuit from 0 to 20V p-p or from 0 to 10V p-p into a 50Ω load. A variable dc-offset facility allows you to offset the open-circuit output by more than ±10V, or by more than ±5V for a 50Ω load. You can also invert the square-wave or pulse outputs. External-sweep facilities permit you to vary the generator's frequency over a 1000:1 ratio from an external 0 to 10V source. The unit operates from 198 to 262V or 99 to 131V ac at 50 or 60 Hz. It measures 270×95×295 mm and weighs 1.8 kg. Fr fr 2500.

ITT Instruments, 346 Edinburgh Ave, Slough, Berkshire, SL1 4TU, UK. Phone 0753 824131.

Circle No 409

2 billion miles out.
There's no acceptable failure rate.
That's why Teledyne Relays is here.

On Voyager 2, TO-5 electromechanical relays made by Teledyne Relays have spent eight years in deep space. And are still operating perfectly.

And this is only one example of the extraordinary reliability of TO-5 electromechanical relays from Teledyne Relays.

This reliability is the reason why the TO-5 has become the industry standard. And it's the reason designers keep specifying it for use in advanced technologies from space probes to weapons systems. From flight controls to test equipment.

In the 24 years since we invented the TO-5 Relay technology, we've supplied millions of relays to a very demanding market; because Teledyne's TO-5 electromechanical relays are not a compromise.

If you are working on a design which calls for unquestioned reliability, work with us. For applications on or under the sea. On or above the earth. Anywhere you need superior performance. Put our quarter century of experience to work for you.

Because—when there's no acceptable failure rate, there's only one acceptable choice—Teledyne Relays.

TELEDYNE RELAYS
Innovations In Switching Technology

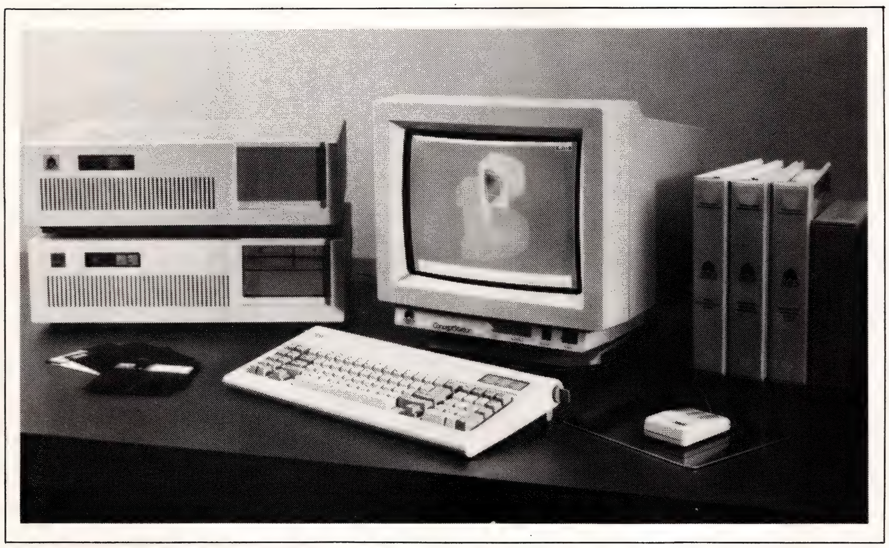
CIRCLE NO 127

12525 Daphne Ave., Hawthorne, California 90250 • (213) 777-0077
European Hqtrs: Abraham Lincoln Strasse 38-42, 6200 Wiesbaden, W. Germany • 06121-768
Belgium Sales Office: 181 Chaussee de la Hulpe, 1170 Brussels • (2) 673-99-88
U.K. Sales Office: Heathrow House, Bath Rd., Cranford, Hounslow, Middlesex, TW5 9QP • 1-897-2501
Japan Sales Office: Taikoh No. 3 Building, 2-10-7 Shibuya, Shibuya-Ku, Tokyo, 150 Japan • (3) 797-6956
France Sales Office: 85-87 Rue Anatole-France, 92300 Levallois-Perret • 1-7587160

© 1986 Teledyne Relays

NEW PRODUCTS

CAE & SOFTWARE DEVELOPMENT TOOLS



CAE WORKSTATION

- *Uses IBM PC/AT and hardware applications accelerator*
- *Provides fast solid-modeling features*

The Conceptstation consists of an IBM PC/AT, enhanced by a proprietary 32-bit, 8M-flops accelerator coprocessor and graphics subsystem. You can run all MS-DOS software, such as productivity and software-development tools, on the PC/AT. The vendor's MCAE software, written in C, runs under the Xenix operating system and makes use of the accelerator coprocessor to achieve maximum analysis and display speed. The MCAE software includes a geometric modeler that can generate solid, surface, or wire-frame solid images; a finite-element modeler; a design-rule processor; a materials-property manager program; and a macro-design language. The workstation is available in two versions: The bundled version includes an IBM PC/AT; a 1.2M-byte floppy-disk drive; a 9.2M-byte RAM; a 60M-byte hard disk; an Intel 80287 math coprocessor; a 3-button optical mouse; a 256-color; 1024×770-pixel monitor; and the vendor's proprietary accelerator and graphics hardware, together with the MCAE software, Xenix, and MS-DOS. The unbundled version includes all of the proprietary items, but you have to provide your own PC/AT and 60M-byte hard disk. Bundled version, $49,000; unbundled version, $36,500.

Aries Technology Inc, 650 Suffolk St, Lowell, MA 01854. Phone (617) 453-5310.

Circle No 410

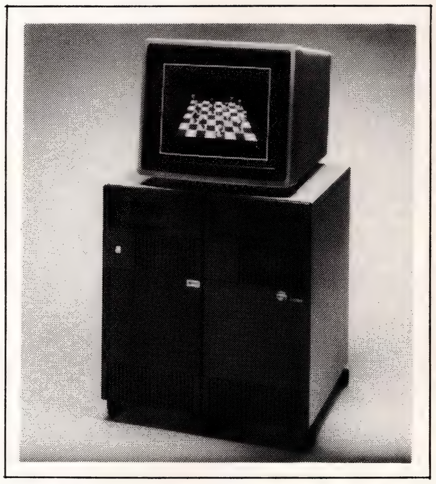
CAD GRAPHICS

- *Replaces PGA, EGA, and CGA boards in IBM PCs*
- *Provides resolution as high as 1024×768 pixels*

The Uni-Screen/PGA is a 2-board graphics set that plugs into one slot of an IBM PC, PC/XT, PC/AT, RT PC, or compatible computer. According to the manufacturer, the board is completely compatible with the IBM Professional Graphics Adapter, but the Uni-Screen/PGA runs PGA-compatible applications software four times faster than does the PGA. It offers resolution as high as 1024×768 pixels, and it can display 16 colors simultaneously from a palette of 4096. (The PGA's resolution is 640×480 pixels, and it can display 256 colors simultaneously.) The board set contains an 80186 μP, two I/O ports, as much as 512k bytes of RAM, and 128k bytes of ROM in which the firmware is resident. The board can drive most 36- and 48-kHz color monitors. According to the vendor, the board can run any PGA-compatible application, as well as applications that use the VDI, CGI, GKS, or DGIS graphics standards. With 800×600-pixel resolution, $2695; with 1024×768-pixel resolution, $2995.

TAT Graphics Group Inc, 1270 Lawrence Station Rd, Building E, Sunnyvale, CA 94089. Phone (408) 734-2202.

Circle No 411



GRAPHICS SUBSYSTEM

- *Provides 1280×1024-pixel resolution*
- *As many as 28 bit-planes of image memory*

The Satellite is a high-resolution color-graphics display subsystem for use with Sun Microsystems (Mountain View, CA) workstations. It's available in several configurations. All units in the line feature a resolution of 1280×1024 pixels and a palette of 16 million colors; the frame buffer can have as many as 28 bit-planes of image memory per pixel. Features include one to four

From The People Who Brought You Revolutionary
OMNI-TACT®

Every DIP, SIP, LIF, ZIF
& PGA Socket/Array
You Need . . .

WHEN YOU WANT 'EM & HOW YOU WANT 'EM
. . . *GUARANTEED*

Choose from the more than 1,000 new Mark precision socket/arrays with Omni-Tact, the first, seamless drawn BeCu contact. Available in standard lead sizes and shapes . . . and, more important, *in configurations to meet your special needs.* Here's what we give you:

- Consistent insertion forces down to 1.75 oz's per line.
- Tight socket-to-socket spacing.
- Uncompromised quality, manufactured to meet and exceed "Mil-Specs"
- On-the-spot, problem solving technical assistance.
- Instant response service from people who care.
- Fastest turnaround in the industry.

In short, Mark has the people, the technology, the products and the service that you've always wanted.

SEND FOR NEW 64 PAGE CATALOG.

Precision Across The Board

mark eyelet, inc.

63 Wakelee Road, Wolcott, CT 06716
Phone (203) 756-8847 TLX: 510-600-7291

CIRCLE NO 128

independent color-display channels, programmable video-display formats, and a user-programmable, writable control store. The design of the frame buffer allows you to update it during display operations, and double buffering facilitates hidden-redraw operations. You can select from a variety of interlaced and noninterlaced display formats, including NTSC, CCIR, and the new HDTV television formats, or you can create your own custom format. The unit provides both 4-bit and 8-bit color-lookup tables, as well as 12- and 24-bit RGB modes of operation. The system comes with two libraries of graphics functions: The Basic Graphics Library (BGL) provides the basic machine-control functions and 2-D graphics functions defined in device coordinates; the High-Level Graphics Library (HGL) provides hierarchical display lists with 3-D functions in a world-coordinate space. The subsystem's image-processing capabilities include integer zoom factors from 1 to 16; separate pan and zoom control for each group of four bit-planes of image memory; and pixel-block transfers. The monitor screen can be 16 in. or 19 in.; both types have a scan rate of 65 kHz and a bandwidth of 110 MHz. From $15,000 to $30,000. Delivery, 30 to 45 days ARO.

Jupiter Systems, 1100 Marina Village Parkway, Alameda, CA 94501. Phone (415) 523-9000. TLX 6713004.

Circle No 412

MULTITASKING FOR PC

- *Multitasking kernel supplements PC-DOS*
- *Controls access to shared data areas*

PCMascot is a multitasking kernel for the IBM PC and compatibles. It allows you to develop real-time applications that use concurrently executing processes for process control or data acquisition. You can divide your application into processes that communicate with each other through a shared data area in memory. The package provides kernel primitives that control access to shared data areas and that can synchronize the execution of different processes. The kernel manages all interrupt-handling functions to simplify the writing of device drivers; however, in time-critical processes, you can include interrupt handling in the process. You implement tasks (processes) as sequential C programs that you compile and link in the usual manner. Because each task is a separate .EXE program, you can combine tasks that use different memory models or that were compiled with different compilers. $795.

Andyne Computing Ltd, 544 Princess St, Suite 202, Kingston, Ontario, Canada K7L 1C7. Phone (613) 548-4355.

Circle No 413

PC-BOARD DESIGN

- *Enhanced hardware speeds design, simulation, and routing*
- *Delivers more performance for less money*

Enhancement options for the Apollo DN3000 workstations now allow it to run this company's PCB Worksystem CAE software. These enhancements include an increase in main memory to 4M bytes and in disk storage to 155M bytes. The PCB Worksystem offers schematic capture, board layout, and, in conjunction with the Tektronix HILO-3 Logic Simulation System, simulation of large logic systems. The software offers both automatic and interactive placement of parts, either on the whole board or on specific areas. You can use a variety of routing strategies, singly or in combination, when making multiple passes to optimize board layout. A complete workstation, consisting of the Apollo DN3000, 4M bytes of memory, 155M bytes of disk storage, a keyboard, a mouse, dual operating systems (Unix 4.2BSD and Apollo Aegis), and Tektronix pc-board design and layout software configured for the DN3000, $49,900.

Tektronix Inc, CAE Systems Div, 5302 Betsy Ross Dr, Santa Clara, CA 95054. Phone (800) 547-1512; in OR, (800) 542-1877; in CA (408) 727-1234.

Circle No 414

MICROCODE TOOL

- *Microcode assembler runs on a variety of computers*
- *Facilities include pipeline macros and looping constructs*

Version 1.10 of the Hale Macro-Meta-Assembler for microcode includes substantial enhancements. The pipeline macros let you assign any microcode field; you can string together existing source macros to create microcode or to create a higher-level macro. You can operate as many as eight pipeline macros simultaneously. The software lets you define errors, so you can assert microprogram design rules; the assembler checks your code against these rules and warns you of any violations. You can insert nonassembling messages at any point in the source code to trace assembly-program flow or to indicate untested routines. The While and Endwhile looping directives allow the assembler to generate code from statements placed between these directives as long as a user-specified condition remains true. An ASCII code-conversion feature lets you

The Power Technology Group of Inland Motor continues to advance the technology in high density Military power conversion.

We have improved our benchmark 1 MHz, zero current switching forward converters for even more demanding applications. We call our new line the RC/RB series of converters and power boosters. This new line now offers as standard features:

- All hermetically sealed semiconductors
- 28 VDC input per MIL-STD-704D & MIL-STD-1275A
- 270 VDC input per MIL-STD-704D
- Vacuum molded case for higher stress levels of MIL-E-5400, MIL-S-901, MIL-STD-202 & MIL-STD-810
- Improved thermal characteristics for −55°C to +85°C operation
- Environmental Stress Screening including power ageing the thermal cycling

Have we had to sacrifice size to achieve these improvements? Not at all. In fact we have actually reduced the module envelope. Now a full 100W of regulated and isolated DC power is available in only 4 in.^{3} (4.6″L x 2.0″W x 0.485″H). Join the growing list of users who have given their military systems the competitive advantage of Inland's 1 MHz power technology. Find out what Inland can do for you by calling (602) 459-1150.

Power Technology Group
Inland Motor
A Division of Kollmorgen Corp.

4020 E. Inland Road, Sierra Vista, AZ 85635
Phone: 602-459-1150 • TWX: 910-973-9869

CIRCLE NO 168

Toko Buffered
Delay Lines
Protect
your data and
your reputation

Because the data your products will handle is priceless, Toko never shortcuts quality. Our automated assembly and 100% testing assure you of the highest reliability at the lowest possible cost.

☐ Available in SIP, DIP and SMT packages.
☐ Transfer-molded epoxy resin package provides superior environmental protection.
☐ Each delay line meets rigid quality control standards—100% testing with seven separate inspections during manufacture.
☐ Lumped Constant Delay Line and IC are integrated into one package for simplified design and assembly.
☐ Backed by Toko...one of the world's largest delay line manufacturers.
☐ Total delay times from 100 pico seconds up to 7 micro seconds ±5%.
☐ Input/output buffering equivalent to 74SO4 (TTL compatible).

A broad range of delay values are available. **For a free catalog, sample and application information contact Toko America today.**

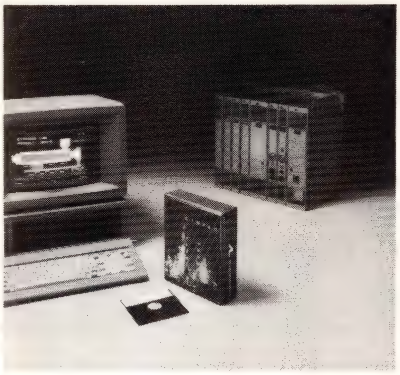
TOKO
TOKO AMERICA, INC.
1250 Feehanville Drive
Mount Prospect, Illinois 60056
(312) 297-0070, TELEX: 724372
FAX (GIII): (312) 699-7864

CIRCLE NO 51

code data in ASCII format. When you invoke the feature, it converts the data to binary form for embedding within the microcode. Thus, when you want to use the same message in different parts of your system, you need only enter it once in ASCII format and then invoke the converter at each occurrence of the message. Relocatable version for the IBM PC, $2300; relocatable versions for VAX, Sun, and Apollo computers, $3500.

Hilevel Technology Inc, 18902 Bardeen, Irvine, CA 92715. Phone (714) 752-5215.

Circle No 415



PROCESS CONTROL

- *Provides both analog and digital I/O*
- *Provides log of control and alarm events*

CIM-PAC is a process-measurement and -control software package that runs on IBM PC, PC/XT, PC/AT, and compatibles. To run the software, you need a math coprocessor, 640k bytes of RAM, an IBM Enhanced Graphics Adapter or equivalent graphics board, a hard disk, and appropriate analog or digital I/O boards. The display module lets you display the status of selected groups of I/O nodes (or of all nodes) in tabular form. Alternatively, you can create pictorial representations of the nodes and animate these by means of color changes and movement to indicate their current status. The event-processor module can automatically initiate tasks in response to monitored times, events, or instructions entered via the keyboard. You can define as many as 100 control loops for the system and independently select the update rate for each loop; you can vary the update interval from once per second to once every 255 seconds. The program provides several password levels to protect the database from unauthorized alterations. The software allows you to use as many as eight PCs in a network; the primary station requires a hard disk, but the secondary stations can be diskless units. $950.

Action Instruments Inc, 8601 Aero Dr, San Diego, CA 92123. Phone (619) 279-5726.

Circle No 416

COMMUNICATIONS

- *Links mini- and microcomputers to IBM mainframes*
- *Provides file transfers between disparate operating systems*

Blast-Host runs under IBM's VM/CMS and MVS/TSO operating systems and uses any of the asynchronous pathways typically found in the mainframe environment to provide file-transfer facilities between the mainframe and a minicomputer or a microcomputer such as an Apple Macintosh or an IBM PC or compatible. According to the vendor, the proprietary transmission protocol provides high-speed, error-free communication over such diverse media as X.25 packet-switched networks, satellite links, and noisy telephone lines. With the addition of a protocol converter, the program can emulate a 3270 terminal. Blast-Host for IBM mainframes, $5500; Blast for minicomputers, $495 to $1295; Blast for IBM PC or Macintosh, $250.

Communications Research Group, 5615 Corporate Blvd, Baton Rouge, LA 70808. Phone (504) 923-0888. TLX 759985.

Circle No 417

Our SCSI selection is getting bigger. And smaller.

Bigger with the addition of a new SMD controller board that's setting speed records and the first SCSI printer interface board. And smaller as we continue to reduce chips and boards through VLSI technology, while adding functions. (Even down to a controller on a single chip.) And there's more that's even too new for this ad. So call 1-800-325-SCSI, and find out what NCR and SCSI can do for you.

SCSI Disk Controller Chip

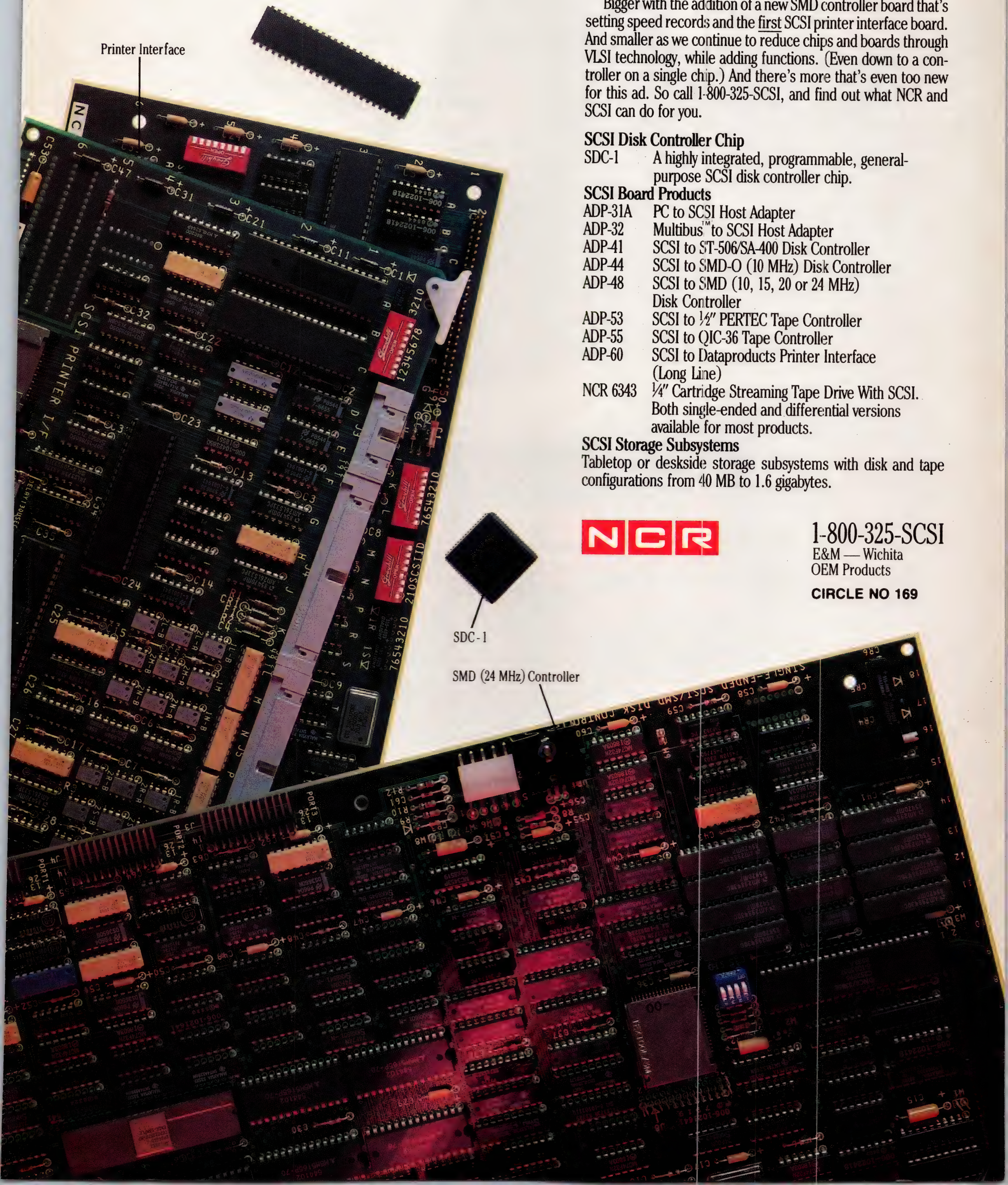
SDC-1	A highly integrated, programmable, general-purpose SCSI disk controller chip.

SCSI Board Products

ADP-31A	PC to SCSI Host Adapter
ADP-32	Multibus™ to SCSI Host Adapter
ADP-41	SCSI to ST-506/SA-400 Disk Controller
ADP-44	SCSI to SMD-O (10 MHz) Disk Controller
ADP-48	SCSI to SMD (10, 15, 20 or 24 MHz) Disk Controller
ADP-53	SCSI to ½" PERTEC Tape Controller
ADP-55	SCSI to QIC-36 Tape Controller
ADP-60	SCSI to Dataproducts Printer Interface (Long Line)
NCR 6343	¼" Cartridge Streaming Tape Drive With SCSI. Both single-ended and differential versions available for most products.

SCSI Storage Subsystems

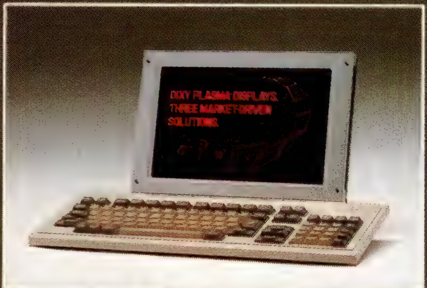
Tabletop or deskside storage subsystems with disk and tape configurations from 40 MB to 1.6 gigabytes.



NCR

1-800-325-SCSI
E&M — Wichita
OEM Products

CIRCLE NO 169



DIXY's new C and D Series plasma displays are high-performance, cost-effective panels with top-of-the-line specifications.

The key is our exclusive thick film technology. It lets our customers offer sharp, brilliant graphics and precise, high-resolution alphanumerics in eye-soothing, flicker-free, jitter-free neon orange.

CHECK AND COMPARE THESE MARKET-DRIVEN BENEFITS.

- Thin, simple design:
  19mm at the periphery, 38mm at the center.
- High 640 x 400 dot density:
  (0.3mm x 0.3mm dot-pitch).
- Wide viewing angle:
  115° (left-right), 140° (up-down); distortion free screen.
- Up to 4,000 alphanumerics on the screen at one time.
- Adjustable brightness control.
- Full CRT (non interlace type) interfacing.
- Series or parallel operation: (RS232C and other composite interfaces).
- Touch screen entry.
- Simple installation:
  Small mounting area, including drive electronics.
- Lower power consumption.
- Other DIXY benefits:
  Value-added engineering for extra reliability and durability; responsiveness to your needs.

DIMENSIONS

MODEL	SCREEN SIZE	WIDTH	HEIGHT	DEPTH
SC SD	9"	276mm	197mm	38mm
LC LD	10"	276mm	213mm	38mm
AC AD	12"	325mm	216mm	38mm

DIXY

FOR WORKPLACE SOLUTIONS

For more information, please contact:
DIXY Corporation, 5-5 Katsuradai 1-chome, Midori-ku, Yokohama, 227 Japan TEL: 045-962-1717, FAX: 045-962-2547, TLX: 3823574DIXY J
KANEMATSU-GOSHO (U.S.A.) INC. HIGH-TECH DEPT. 543 W. Algonquin Road, Arlington Hgts., IL 60005 TEL: (312) 981-5693, FAX: (312) 981-9076, TLX: TWX (910) 687-284, WU-28-2438
CRAFT DATA INC. 27022 Cordero Lane, Mission Viejo, California 92691 TEL: (714) 582-8284, TLX: 751875 CRAFT DATA

CIRCLE NO 172

EDN
PRODUCT MART

This advertising is for new and current products.

Please circle Reader Service number for additional information from manufacturers.

PROJECT MANAGEMENT CONTROL

Exceptional Planning and Tracking

- Menu driven — easy to use
- Provides upload/download interface
- BASELINE comparative reports
- Multi-level sort
    - Network diagram
    - Gantt/bar charts
    - Earned value analysis and graph
    - Funding schedule and graph

PMS-II - $1295; Demo -$50
Formatted for MS-DOS

(619) 458-1327

NORTH AMERICA MICA, INC.
5230 Carroll Canyon Road, Suite 110
San Diego, California 92121

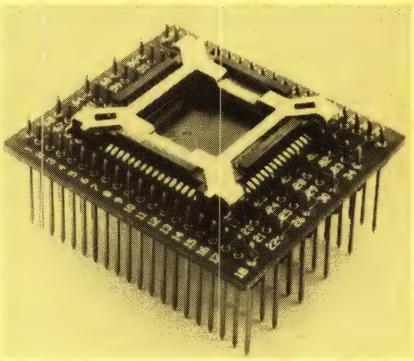
CIRCLE NO 325

TSA-100 AD TEXT

SINGLE BOARD 16-CHANNEL 40 MHZ LOGIC ANALYZER transforms **IBM PC/XT/AT** into complete digital analysis workstation. Includes timing and state analysis and is expandable to 88 channels. The TSA-100 features rising or falling edge data capture, logic 1,0,X pattern triggering, and an external clock qualifier for multi-cycle microprocessor instructions. User friendly menu driven software completes the system. $1395 for the TSA-100 (16 channel analyzer card, two 8 bit probes, software, and accessories).

PC LABS
976 W. Foothill Blvd., Suite 268
Claremont, CA 91711
(714) 596-7851

CIRCLE NO 326



LEADLESS CHIP TO WIRE WRAP ADAPTER

Saving hours of breadboarding, the ANC-9068 adapters provide the designer with a labeled test point for each pin and are available for PCC, LCC and PGA 68-pin type chips. WW pins are on .3″ centers using 4 square inches of space. Unit pricing is $49.00.

Antona Corp.
2100 S. Sawtelle Blvd., L.A., CA 90025
(213)473-8995

CIRCLE NO 327

HVAC
TRANSDUCERS

Now, bigger discounts than ever

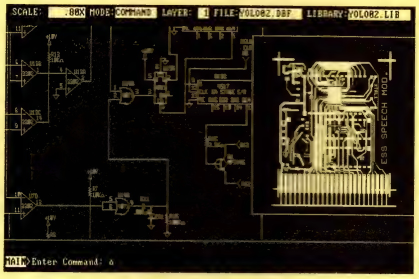
- Medium to very low pressures
- To 0.25% accuracy

Call for **Free** test unit and low prices

800-323-7115 In PA, 800-323-7114

Robinson-Halpern COMPANY
A Subsidiary of Teleflex Incorporated (USA)

CIRCLE NO 328


SCALE: .88X MODE:COMMAND LAYER: 1 FILE:VOLO82.DBF LIBRARY:VOLO82.LIB
ESS SPEECH MOD.
MAIN Enter Command:

SCHEMATIC CAPTURE TO PCB LAYOUT $695.

Before you buy EE designer™, FutureNet™, PCAD™ etc., check our TOTAL CAD solution & save $$$. Our Schematic/PCB editor supports 15 levels of hierarchy, 50 layers, auto. parts pkg., rat's nest, real time data integrity checker, rubber banding, true 1 Mil resolution, unlimited trace widths, GND plane. Over 100 powerful editing commands. Netlist to SILOS, SPICE, LVS, BOM, Wirelist GERBER, etc. IBM/GSS VDI drivers supported. 30 days eval. $75. VAX/VMS from $1995. **Interactive CAD Systems** 2352 Rambo Ct., Santa Clara, CA. 95050 (408) 970-0852.

CIRCLE NO 329

Glide Through PCB Design With *Tango-PCB.* Just $495.

Create the toughest board designs with powerful layout software that's a snap to use. Function-rich **Tango-PCB** supports eight layers, true power and ground planes, **OrCAD**™ or **Schema**™ netlist input, and more. For IBM PC/XT/AT. Compare features and you'll buy **Tango-PCB**. Just **$495**. Or try full-function Demo Package, just **$10**. Thirty-day money-back guarantee. Order toll-free: 800 433-7801 In CA: 800 433-7802 VISA/MC

ACCEL Technologies, Inc.
7358 Trade St.
San Diego, CA 92121

TangoPCB™

CIRCLE NO 330

To advertise in Product Mart, call Joanne Dorian, 212/576-8015

ELECTRONIC

ENGINEERS **TECHNICIANS**
MANAGERS *You Need* **BUYERS**

PARTLISTER

For PC Compatibles

GENERATES ERROR FREE REPORTS

Parts Listing · Summary · Bill of Materials

* * *

Easy to Learn · **Easy to Use** · **Well Documented**

* * *

DATA FIELDS INCLUDE

Reference Designator	**Mil Spec Number**
Part Type/Value	**Preferred Manufacturer**
Company Part Number	**Description (Comments)**
Cost	

* * * * * * * * * * * * * * *

NOW

$59.95

Add $3.00 Shipping and Handling
(In California add 6.5% sales tax)

Send check or money order to:

LIVEWIRE SOFTWARE
P.O. Box 773
Pacific Palisades, CA 90272
(213) 454-4492

LIVE WIRE **SOFTWARE**

CIRCLE NO 331

SOLENOID
Engineering Manual

Send for the latest 68-page Solenoid Engineering Manual from Deltrol • Packed with useful information including performance data, stroke/force curves, selection factors • Industry's broadest range of miniatures, C frames, D frames, power surge, and tubular solenoids.

DELTROL
controls
DIVISION OF DELTROL CORP.

2745 S. 19th St.
Milwaukee, WI 53215
Phone 414/671-6800
Telex 2-6871

4305

CIRCLE NO 332

IEEE-488 CONTROL FROM YOUR PC.

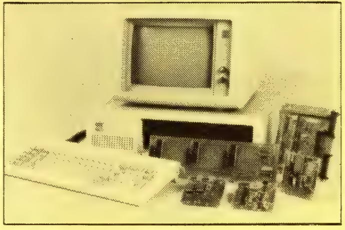
- ☐ Emulate hp and Tektronix controllers.
- ☐ Fast and easy-to-use. Thousands sold.
- ☐ Program in BASIC, C, FORTRAN, or Pascal
- ☐ Hardware and software - $395 complete.

cec

Capital Equipment Corp.
99 South Bedford St.
Burlington, MA. 01803
Call today 617-273-1818

CIRCLE NO 333

MODULAR DATA ACQUISITION



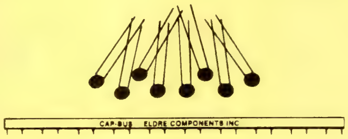
- **For IBM & Compatibles**
- **Flexible and Inexpensive**
- **Money Back Guarantee**
- **Free Technical Support**

Fast Delivery

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726

CIRCLE NO 334

ELIMINATE DECOUPLING CAPACITORS

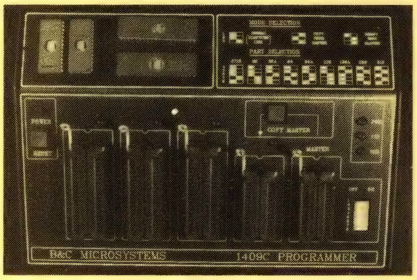


CAP-BUS® CAPACITOR/BUS BAR

Eliminate the decoupling capacitors and the power and ground traces from your PCB for more reliability. CAP-BUS® has a distributed capacitance of .05 micro-farads per lin. in., at 50 VDC with low inductance and low impedance. The capacitor and the bus bar have been joined together for CAP-BUS®; a more efficient capacitive decoupled power distribution system, increasing IC density on a two sided board.

ELDRE COMPONENTS, INC.
1500 Jefferson Rd.
Rochester, NY 14623
(716) 427-7280

CIRCLE NO 335

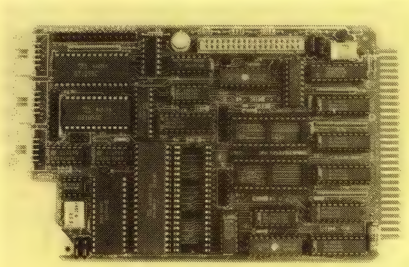


UNIVERSAL EPROM PROGRAMMER $599!!

- Built in timer eraser optn; foam pad area
- Menu selection; No modules or adapters
- User friendly softw; Complete help menu
- Direct tech. support; Full 1 yr. warranty
- Stand alone duplication & verify
- Quick pulse alogrithm: 27256 under 60 sec
- All 24/28 pins to 27011 & CMOS E(E)PROMS
- Micros: 8741,2,4,8,9,51,52,55,9761, & CMOS
- Auto baud RS232 to 19.2k; Free PC Drivers
- Ofset/split Hex, Binary, Intel & Motorola 8, 16 & 32 bit files; Kits from $99!

B&C Microsystems
6322 Mojave Dr., San Jose CA 95120
Ph (408) 997-7685 Tx 4995363 Visa & MC

CIRCLE NO 336



CMOS 80C88 SINGLE BOARD STD BUS COMPUTER

Features the 16-bit 8088 with 8087 coprocessor socket and 1 Mbyte addressing, On-board functions include 2 JEDEC 28-pin memory sockets for up to 128K bytes of RAM. EPROM, or EEPROM. Includes one RS-232/RS-422 serial port, 8259A interrupt controller, 3 16-bit counter/timers, SBX connector, and Watchdog timer. Available in NMOS/TTL or CMOS from

WinSystems, Inc.
PO Box 121361
Arlington, TX 76012
817/274-7553

CIRCLE NO 337

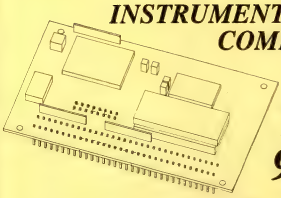
IBM PC to HP file interchange !!!

1. PCLIF (Rev 2.5) - New release of the software utility that allows the transfer of files between an IBM PC and HP computers using floppy disks.
   - 5.25" transfers don't require any additional hardware !
   - 3.5" disk transfers require an ISS FDD35 drive system.
   - runs on the IBM PC, XT, AT and the HP Vectra.
2. FDD35 - An external 3.5" DS/DD floppy disk drive system for the IBM PC and XT.
   - easy connect to IBM PC disk drive controller.
   - can be used by DOS and PCLIF.

INNOVATIVE SOFTWARE SYSTEMS
1611-D Crenshaw Blvd. Suite 122
Torrance, CA 90509
(213) 544-2465

CIRCLE NO 338

FORTH INSTRUMENTATION COMPUTER



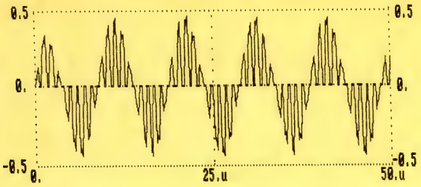
TDS 9090

A powerful control computer based on the new Hitachi 6303Y and high level language Forth. 100mm × 72mm. 30K bytes RAM, 16K dictionary RAM/PROM, 256 bytes EEPROM, 16K Forth. You can attach 64 key keyboard, LCD and I^2C bus peripherals. Built in are interrupts, multitasking, time of day clock, watchdog timer, full screen editor and symbolic assembler. 32 parallel and two serial ports. Single power supply and low power 3mA OPERATIONAL mode. Buy direct from England. $295 inc airmail. Phone +44-1-520-0442.

Triangle Digital Services Ltd
100a Wood Street, London E17 3HX

CIRCLE NO 339

To advertise in Product Mart, call Joanne Dorian, 212/576-8015

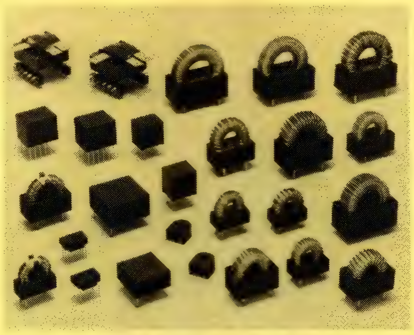


Electronic Circuit Analysis

ECA 2.2 is a high performance analog circuit simulator with AC, DC, Transient, worst-case, Fourier and Monte-Carlo analysis. A full nonlinear simulator, including nonlinear capacitors and inductors. Parts can vary over tolerance range and also with time, temperature, or frequency. Includes macro-models, complex y-parameters, transmission lines, and the ability to sweep components over a range of values. Easy to use. Fully interactive, and also batch mode. Analyze circuits bigger than 500 nodes. Runs on IBM-PC/XT/AT and campatibles. **ECA 2.2-$675. EC-Ace,** a subset of **ECA-2.2-$330.** Demo disk available.

TATUM LABS
P.O. BOX 698
SANDY HOOK, CT 06482
(203) 264-3755

CIRCLE NO 340



MAGNETIC COMPONENTS FOR SMPS

Type 94Z thru 99Z magnetic components for SMPS provide design flexibility and wide range of characteristics in standard packages. Available are EMI common-mode suppression inductors, energy-storing power chokes and transformers: current-sense, base-drive, switching, and high-speed trigger. Write for Bulletin 40500. **Sprague Electric Co.,** P.O. Box 9102, Mansfield, MA 02048-9102. For applications assistance, contact our Customer Service Center at (209) 732-4585.

CIRCLE NO 341

NEEDS TOO SMALL FOR THE BIG BOYS? HYDELCO HYBRIDS ARE JUST RIGHT FOR YOU

■ Simple to highly sophisticated ■ Usually around $3,500-$7,500 to develop ■ As little as 8 weeks from your breadboard to delivery ■ Design changes easily accommodated ■ Quantities from 1 to 100,000 and up ■ You own designs and tooling.

CALL OR WRITE: FAX (805) 499-3731

(805) 498-3688

HYDELCO INC. Manufacturer of Hybrid Microcircuits

1176 Tourmaline Drive • Newbury Park, CA 91320

CIRCLE NO 342

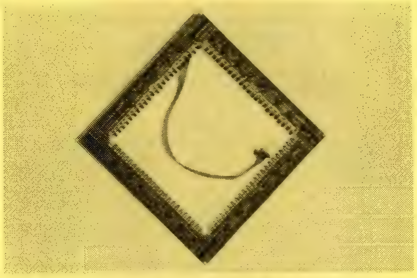
8051

8048

SIMULATORS - CROSS ASSEMBLERS - PROGRAMMERS - SIM51 and **SIM48** Software Simulators run on IBM-PC, CP/M-80, MS-DOS. Designed for validation & debugging application software. Simulation includes all on chip functions plus expansion chips. $250, one year **FREE** updates. Formats: PC-DOS 2.x DSDD, CP/M-80 8″ SSSD, many 5¼″ formats. Cross Assemblers and EPROM pgmrs also available. **Logical Systems Corp.** 6184 Teall Station, Syr., NY 13217 (315) 478-0722

Logical Systems

CIRCLE NO 343



25 MILLIWATTS
Infrared Touch Sensor

Matches LCD Power Consumption without degrading the picture. Perfect for portable equipment and wherever small size and low power consumption are required.

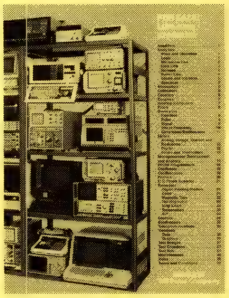
We will do custom design to match your particular requirements.

For information write to:

Insight Technology
945 Turquoise St., Suite G
San Diego, CA 92109
Or Call Anytime (619) 452-1459

CIRCLE NO 344

LIKE-NEW INSTRUMENTS FOR SALE!

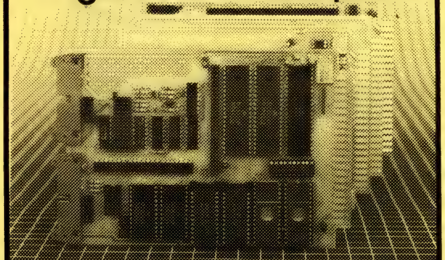


Thousands of bargain-priced electronic instruments – with warranties – available now. Analyzers, PROM programmers, oscilloscopes, printers, recorders, terminals...much more. Call for free catalog: Eastern Time Zone (including Miss, Tenn, Ala) (800) 225-1008, in Mass (800) 643-1011. All other locations (800) 227-8409, in Cal (800) 331-3440.

Genstar REI Sales Company

CIRCLE NO 345

6809
Single Board Computer



6809 MPU, 2 serial ports, 4 parallel ports, RAM, EPROM, real-time clock, watchdog timer, 44-pin 4.5″ × 6.5″ PCB

EXPANSION MODULES: RAM, EPROM, CMOS RAM/battery, analog I/O, serial I/O, parallel I/O, counter/timer, IEEE-488, EPROM programmer, floppy disks, cassette, breadboard, keyboard/display.

WINTEK

Wintek Corp.
1801 South Street
Lafayette, IN 47904
800-742-6809

CIRCLE NO 346

FREE 52 PAGE CATALOG AND APPLICATIONS GUIDE

AFFORDABLE ENGINEERING SOFTWARE

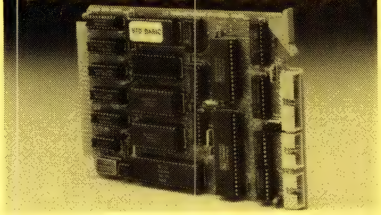
CP/M MSDOS TRSDOS PCDOS

PDP — Plotter Driver Program For multi and single pen plotters	$72.95
XFER — Transfer Function Synthesis Transfer functions/ Electronic circuits	$72.95
TEKCALC — Scientific Calculator Program Screen graphics/ Statistics/ Programmable	$72.95
COMCALC — Communications Design Spreadsheet Communications budget calculator	$72.95
RIGHTWRITER — Report Proofreader Program Version 2 — Applies 2,200 rules of English	$97.95
ACNAP — AC Network Analysis	$72.95
DCNAP — DC Network Analysis	$72.95
SPP — Signal Processing Program	$72.95
PLOTPRO — Scientific Graph Printing	$72.95
PCPLOT — High Resolution Graphics	$72.95
LOCIPRO — Root Locus Analysis	$72.95
ACTFIL — Active Filter Design	$72.95
STAP— Static Thermal Analysis	$72.95
MATRIC MAGIC — Matrix Manipulation	$72.95

BV Engineering Professional Software
VISA
(714) 781-0252
2200 Business Way, Suite 207, Riverside, CA 92501 U.S.A.

CIRCLE NO 347

STD BUS USERS!



The 890 Z80A Multifunction CPU card is an integrated hardware/software solution for industrial control applications.

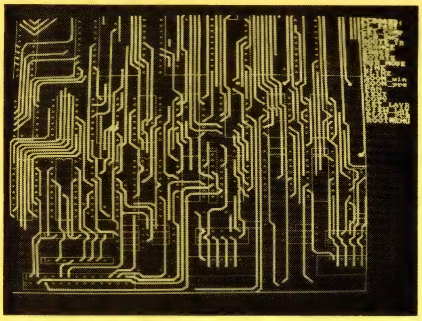
- STD BASIC™—Resident, fast, floating point BASIC
- Generates ROMable code
- 4 MHz Z80A processor
- 128K of memory addressing
- Dual RS-232C serial ports
- 4 counter-timer channels
- Auto run capability
- 8 digital I/O lines
- 16K static RAM
- Status LED
- Object Code Debug Monitor
- Peripheral cards available
- 5 year warranty

Call 303-426-8540 For Immediate Response

OCTAGON SYSTEMS CORPORATION
6510 W. 91st Avenue
Westminster, CO 80030

CIRCLE NO 348

To advertise in Product Mart, call Joanne Dorian, 212/576-8015



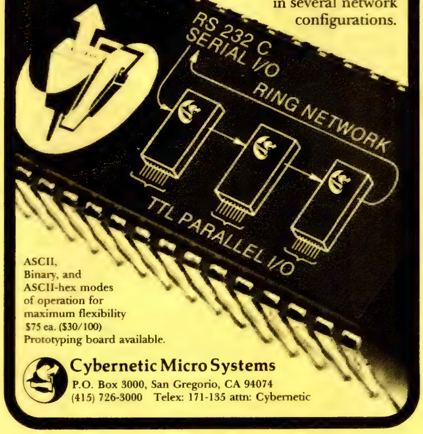
AutoPCB will Auto-Route your **Printed Circuit Board** with mainframe class performance at only **$2,500** (1 hr. 30 min. for 250 IC circuit w/95% completion). It features Schematic Capture, Netlist, parts list, parts placement, Rat's Nest, Multiple Routing Strategies, fine line, 45 deg. turn, Ripout and Reroute, SMT, 24 trace layers, 60″ × 60″, can handle 3000 IC Board, buried via, 4,500 generic parts in library. Requires AutoCAD to run.

PRO. LIB, Inc.
624 E. Evelyn Ave., Suite F
Sunnyvale, CA 94086
Tel. (408) 732-1832 Telex 9102406289 Prolib UQ

CIRCLE NO 349

CY232 NETWORK CONTROLLER AND PARALLEL-SERIAL INTERFACE

will connect any RS232 CRT or computer to any 8-bit parallel TTL I/O port and works with one port or up to 255 parallel ports in several network configurations.



ASCII,
Binary, and
ASCII-hex modes
of operation for
maximum flexibility
$75 ea. ($30/100)
Prototyping board available.

Cybernetic Micro Systems
P.O. Box 3000, San Gregorio, CA 94074
(415) 726-3000 Telex: 171-135 attn: Cybernetic

CIRCLE NO 350

Quelo® 68000 Software Development Tools

Quelo Assembler Packages are **Motorola compatible.** Each package includes a macro assembler, linker/locator, object librarian, utilities for producing **ROMable code**, extensive indexed typeset manuals and produces **S-records**, Intel hex, **extended TEK hex, UNIX COFF** and symbol cross references. **Portable source** written in "C" is available. It has been ported to a variety of mainframes and minis including **VAX.**

68020 Assembler Package

For CP/M-86, -68K and MS/PC-DOS ....$ 750

68000/68010 Assembler Package

For CP/M-80, -86, -68K and MS/PC-DOS .....$ 595

68000 **"C" Cross Compiler**

For MS/PC-DOS by Lattice, Inc.

With Quelo 68000/68010 Assembler Package $1095
With Quelo 68020 Assembler Package $1250

Call **Patrick Adams** today:

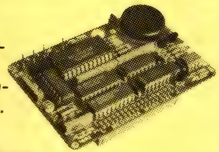
Quelo, Inc.
2464 33rd W. Suite #173
Seattle, WA USA 98199
Phone 206/285-2528
Telex 910-333-8171

COD, Visa, MasterCard

Trademarks: CP/M, Digital Research; MS, Microsoft Corporation; Quelo, Quelo, Inc.

CIRCLE NO 751

MULTIBUS:
Your Time Has Come!



The mSBX-241™ Multimodule is a robust, precision Real-Time Clock/Calendar in SBX format with on-board battery backup.

General Features:

☐ For high performance systems: no wait states or software overhead
☐ Attaches to all SBX and BLX compatible Multibus boards
☐ Programmable alarm clock and periodic interrupts
☐ 12 or 24 hour time modes, in both BCD and binary format
☐ Internal 100 year calendar with leap year compensation
☐ Selectable automatic Daylight Savings compensation
☐ Contains fifty bytes of general purpose non-volatile RAM
☐ **RMX-86/286 drivers supplied on diskette**

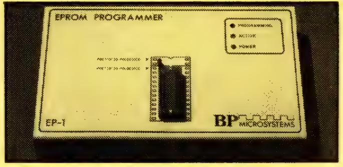
For more information contact:

Medinova Corporation
Intelligent Systems Group
244 West Court, Palatine, Illinois 60067
Telephone (312) 934-4700

Multibus, Multimodule TM Intel Corp.

CIRCLE NO 752

EPROM PROGRAMMER $349

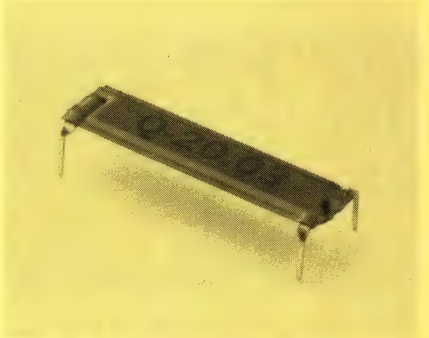


The EP-1 is a great value, here's why:

- IBM PC Software included or RS-232 to any computer
- ASCII Command driven operation; All intelligence in unit
- Reads, Programs, Copies over 150 types from 2716 to 27512
- Optional Intel microcontroller programming head
- Menu-driven Chip Selection; No Personality Modules
- Fast, Slow, Quick-Pulse Programming Algorithms
- Intel (8080 & 8086), Motorola, Tekhex, Straight Hex Files
- Splits Files by Base Address and Odd/Even (16 bit systems)
- Gold Textool ZIF IC socket
- Generate & Set Checksums
- Over-Current Protection
- 8 Baud Rates 300 to 38,400
- Full One-Year Warranty
- 5,12.5,21,25V Programming
- U.V. Erasers from $34.95
- Same Day Shipment

BP MICROSYSTEMS
10681 Haddington, #190 / Houston, TX 77043
(713) 461-9430 (800) 225-2102

CIRCLE NO 753



SIMPLIFY BOARD LAYOUT

MICRO/Q ceramic decoupling capacitors share board mounting holes with IC pins to simplify board design. Now add more active devices with increased density in the same space, or design the same package on a smaller board.

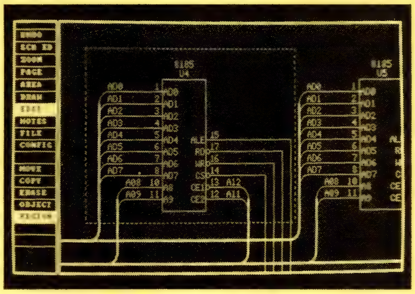
Rogers Corp., 2400 S. Roosevelt St., Tempe, AZ 85282. 602/967-0624

CIRCLE NO 754

---

smARTWORK® Circuit-Board-Artwork Software. For only $895, **smARTWORK®** lets the design engineer create and revise printed-circuit-board artwork on the IBM Personal Computer. Forget the tedium of taping it yourself or waiting for a technician, draftsman, or the CAD department to get to your projects. With **smARTWORK®** you keep complete control over your circuit-board artwork from start to finish. Call or write to **Wintek Corporation**, 1801 South Street, Lafayette, IN 47904-2993. (317) 742-8428, (800) 742-6809.

CIRCLE NO 755



FREE DEMO DISK

SCHEMA is a complete, integrated schematic drawing software package for IBM Personal Computers. Use **SCHEMA** with your PC to draw schematics and automatically generate design documentation such as Wire and Net Lists, Bills of Materials, Design Rule Checks, etc. **SCHEMA** is $495 and supports most common PC hardware configurations. Call or write today for a *free* demo disk and brochure.

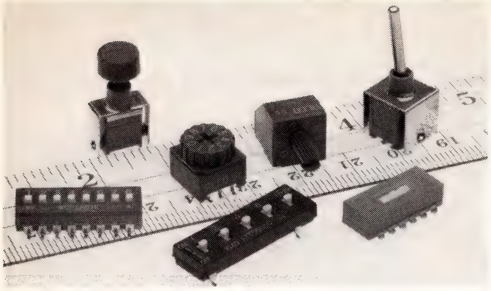
OMATION INC.
1701 N. Greenville Ave., Suite 809
Richardson, TX 75081
(214) 231-5167

CIRCLE NO 756

Frequency synthesizers produce precision frequencies, governed by a high-stability frequency standard. With easy, fast remote programming, they are vital in advanced measurement or production systems and serve as stand-alone test equipment. Properties, specs, applications + prices of the PTS 040, 160, 250 + 500 are given. Data sheets on 2 new units, the PTS 120 and 160/250 Delta are included. **Programmed Test Sources, Inc.**, 9 Beaver Brook Rd., P.O. Box 517, Littleton, MA 01460 (617-486-3008)

CIRCLE NO 757

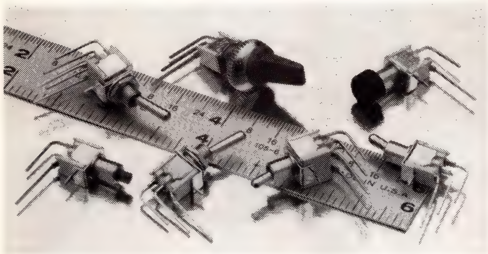
To advertise in Product Mart, call Joanne Dorian, 212/576-8015



SURFACE MOUNT (SMD) SWITCHES

ALCOSWITCH has surface mount switches, consisting of: AD series DIP and AA/C, AR series DIP programming switches, sub-miniature toggle/push-button the SMT/P series switches, and the AS series auto-insertable slide switches. The DIP switches are available in 2 through 10 positions with optional integral pull up resistors or diodes. The SMT/P switches are in single or double-pole, while the AS slide switches are in one, two, four , or six-poll versions. All are molded from high temperature polymers, designed specifically to withstand vapor-phase or infra-red reflow soldering, and allow for aqueous or solvent cleaning. For more information Call (617) 685-4371, **ALCOSWITCH** 1551 Osgood Street, North Andover, MA 01845.

CIRCLE NO 66



"tiny" VRA TOGGLE AND PUSHBUTTON SWITCHES

ALCOSWITCH offers right angle & vertical right angle termination options for the extensive TT/TP Series subminiature "tiny" toggle and pushbutton switches. Intended for high density PC board layouts. The TT/TP-VRA options combine .3X .3X .2 case size with on-edge mounting. These features maximize switch space density, allowing the design engineer room for miniaturization or additional components. Rated at 0.4VA @ 20VDC maximum. For more information Call (617) 685-4371, **ALCOSWITCH**, 1551 Osgood Street, North Andover, MA 01845

CIRCLE NO 105

ADVERTISEMENT

CUSTOM SWITCHES

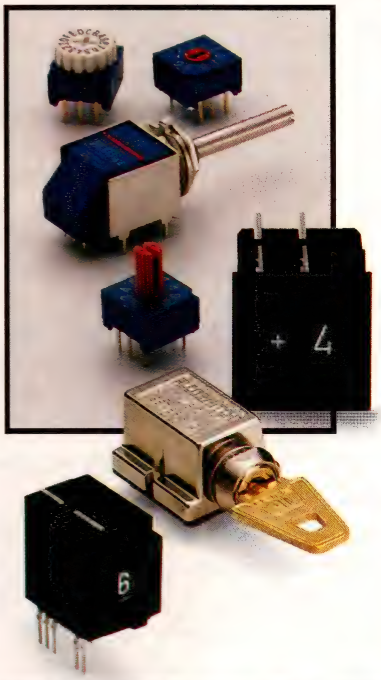
ALCOSWITCH has provided "Application Specific" switch designs to some of the industry's largest OEM's. From sub-miniature snap switches to large power rocker types, our engineers can custom design a switch to meet your unique switch application requirements. For more specific information on our custom design capabilities CALL TODAY, (617) 685-4371, **ALCOSWITCH** 1551 Osgood Street, North Andover, MA 01845.

CIRCLE NO 144

CODED SWITCHES

BCDiversity.

BCD—Better Coded Dependability.



Good reasons to switch:

Rotary DIPs

1. Four actuator styles.
2. Upright or right angle.
3. BCD and complement codes.
4. Hexidecimal and complement codes.
5. Permanently sealed for wave soldering and cleaning.

Pushwheels

1. Broadest line of codes and sizes.
2. Extended PC boards or PC terminals.
3. Panel mountable from front or rear.

Key Codes

1. Up to 31 different codes per switch.
2. PC or turret terminals.
3. Compact and pickproof.

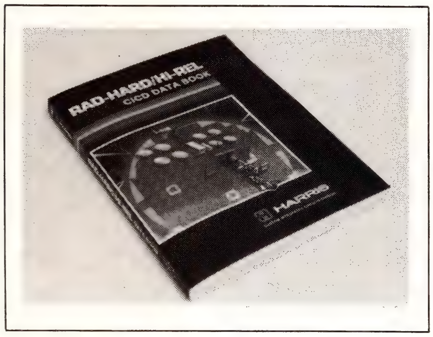
For a catalog, applications help, free product samples, or a quotation, call or write ALCOSWITCH, 1551 Osgood Street, North Andover, MA 01845, (617) 685-4371. TWX: (710)342-0552. FAX: (617) 686-9545.

AUGAT® ALCOSWITCH®

Quality and Innovation

See Us at Electro Booth 1859-65 & 1860-66

CIRCLE NO 183



Data book details rad-hardened products

This book provides technical specifications on the company's rad-hardened products. Containing 496 pages, it features data sheets of such products as CMOS 16k-byte static RAMs, 80C85 and 80C86 microprocessors and peripherals, operational amplifiers, analog switches, comparators, multipliers, and data-communications interface devices. In addition, a section covers the manufacturer's CMOS/analog/digital standard-cell library, which includes 32 individual cells. The data book features other sections pertaining to microwave gallium arsenide products, secure-communication ICs, the effects of radiation on CMOS, and die sales and ordering information.

Harris Corp, Semiconductor Sector, Box 883, Melbourne, FL 32901.

Circle No 418

Report on reliability

If your target system is subject to extensive storage periods and relatively short operating times, you may find this data book and software system useful. According to the book, the disparity between these two time periods will cause most failures to occur during the nonoperating period. The book, *NONOP-1, Nonoperating Reliability Data-1986*, and the system, RAC-NRPS (nonoperating reliability prediction software), help in predicting the impact of nonoperating periods on system reliability. To use the software, you need an IBM PC, PC/XT, or PC/AT; one 10M-byte hard-disk drive or two floppy-disk drives; 348k-byte available memory; an IBM-compatible printer; and a monitor and video card. Book only, $150 ($160 outside the US); book and system, $1400 ($1450 outside the US). For airmail shipments, add $15. To order a demonstration disk of the system, call (315) 330-4151.

Reliability Analysis Ctr, RADC/RAC, Griffiss AFB, NY 13441.

INQUIRE DIRECT

Document discusses progamming, languages

This 39-pg document addresses the complexities of microprogramming and alternative microprogramming languages. In addition to examining the problems specific to microprogramming and offering traditional and unconventional ways to solve these problems, the publication provides information on the vendor's Metastep language. It includes a discussion of the major components of the language and detailed examples of representative and actual microprograms. Examples illustrate how to embed design-rule constraints within the structure of the language and within macro instructions.

Step Engineering, 661 E Arques Ave, Sunnyvale, CA 94086.

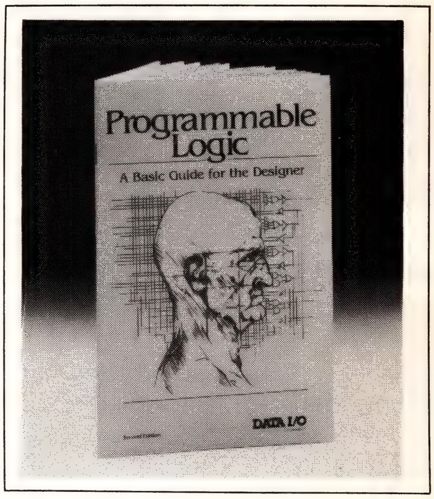
Circle No 420

Guide to add-in memory

This 80-pg booklet is a designer's guide to add-in memory. It contains data on 20 system buses, details of memory design for high-performance buses, elements to consider when configuring a system and selecting memory products, analyses of economic factors, and an industry overview. The final chapter of the guide describes the manufacturer's line of DEC-compatible memories and memories for high-performance microcomputers. A table of specifications completes the treatment.

Clearpoint Inc, 99 South St, Hopkinton, MA 01748.

Circle No 421



Booklet delves into programmable logic

This 30-pg booklet examines the topic of programmable logic. Sample chapters ask (and answer) such questions as "What is a programmable logic device?" and "Why was programmable logic developed?" The pamphlet also describes the different types of programmable logic devices, how to use the logic, and a design example. A glossary and references are included.

Data I/O Corp, Box 97046, Redmond, WA 98073.

Circle No 422

All about power supplies

This 1987 catalog of the manufacturer's power supplies, which are available with outputs of 1 to 200V (2A), lists standard features, options, prices, and ordering information. The 56-pg catalog contains photos and outline drawings, and it illustrates typical applications.

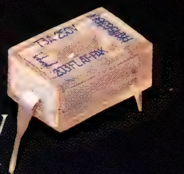
Acopian, Box 638, Easton, PA 18044.

Circle No 423

New Product File

Flat-Pak™

DIP & SMD Fuses



- Slo-Blo® design: 250 Volts, 1 thru 5 Amperes, Stamped "T" and color-coded blue. • Fast-Acting design: 250 Volts, 1/16 thru 5 Amperes, Stamped "F" and color-coded red. • New low profile rectangular shape (.346″(L) x .245″(W) x .160″(H)) for easy fuse identification. • U.L. Recognized and C.S.A. Certified. • Visible element for blown fuse indication. • Available with DIP or surface mount styles. • Unique DIP design and magazine cartridge packaging make Flat-Pak™ ideal for high speed automatic insertion.

Patent Number: 4,563,666

Littelfuse Tracor
PRODUCT BULLETIN
NEW! Littelfuse Flat-Pak Fast-Acting DIP Fuses
PRODUCT BULLETIN
NEW! Littelfuse Flat-Pak Slo-Blo DIP Fuses
FIRST AGAIN

Call your Littelfuse representative, distributor or (312) 824-1188 for Flat-Pak Product Bulletins 1025 and 1026, samples, pricing and delivery dates.

Making good ideas work for you.

Littelfuse® Tracor

800 E. Northwest Highway • Des Plaines, IL 60016
(312) 824-1188
CIRCLE NO 170

© Littelfuse Inc. 1986

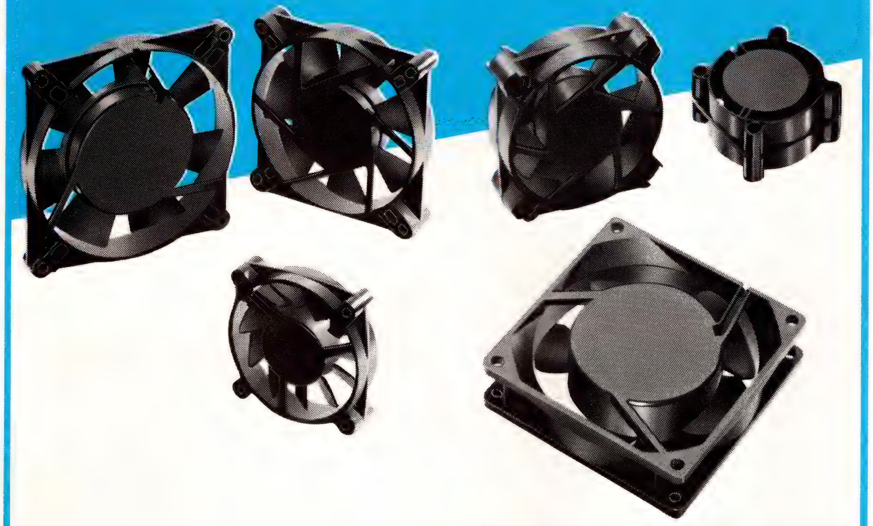
Tutorial helps to learn C

The C Trainer consists of a textbook and an interpreter. The book contains chapters on expressions, declarations, initializations, arrays and pointers, and macros. The interpreter runs on various systems and provides fine control of the execution and debugging of a C program or fragment. You may stop a program at any point, and you can inspect and change the values of active variables. Program modifications are effective immediately with no need to wait for compiling, assembling, and link editing. Also, you can trace function calls, statements, and expressions separately or together. The interpreter's programs range from introductory to advanced. For Macintosh, IBM PCs, PC/XTs, and PC/ATs, the interpreter costs $99. For other systems, the price is higher. The book costs $22.95. Shipping and handling is $5 extra.

Catalytix Corp, 55 Wheeler St, Cambridge, MA 02138.

INQUIRE DIRECT

Ultra-thin, super-durable D.C. fans



(Manufactured by SHICOH GIKEN CO., LTD.)

Fan technology has been developed to a fine art. Our advanced cooling fans are lighter and more compact, and offer low magnetic noise and long service life.

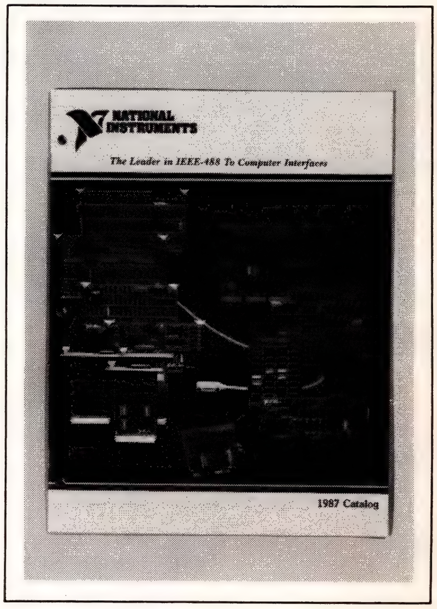
Size (mm)	Noise (dB)	Airflow (CFM)
40×40×20	37	4.2
60×60×20	30	10.6
60×60×15	32	10.6
80×80×20	32	14.1
80×80×15	33	12.4
90×90×15	35	24.7

- ■ A better cooling effect
- ■ Low-noise
- ■ Low starting current, low running current
- ■ Linear Switching System reduces sparkling noise

For more details, please contact:

B.E.A. COMPONENTS, INC.
3190 Coronado Drive, Suite B, Santa Clara,
California 95054
Tel. (408) 980-1844 Fax. (408) 980-1006

PIONEER INTERNATIONAL INC.
Mita Kokusai Bldg. 1-4-28, Mita Minato-ku,
Tokyo 108, Japan
Tel. Tokyo (03) 453-3321 TLX: J26952 TERNPION



IEEE-488 bus interface products cataloged

This 1987 catalog covers the vendor's IEEE-488 bus interface products, which are available for IBM PCs, PC/XTs, PC/ATs, RT PCs, and compatibles; for Apple, AT&T, Tandy, Texas Instruments, Apollo, Sun, Compaq, Motorola, and NCR machines; and for the Q Bus, Unibus, VME Bus, Multibus, S-100 Bus, STD Bus, and SBX Bus. The 24-pg document includes the manufacturer's newest offerings, such as a family of intelligent interfaces that support AT&T 3B2 computers and TI Explorer workstations. In addition, it contains information about bus extenders, converters, and testers, as well as data on training for the IEEE-488 bus.

National Instruments, 12109 Technology Blvd, Austin, TX 78727.

Circle No 425

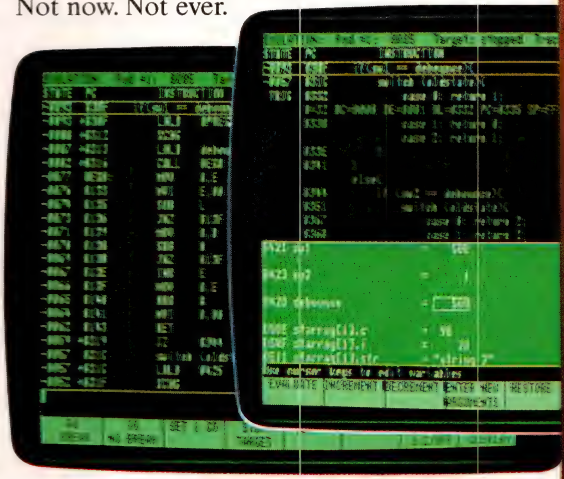
NOW. 68000 Emulation!
Call for demo

Echo: What high level source code debugging should have been from the beginning.

Nobody does what our μP development system does: lets you debug in high level while emulating at full speed; then a single keystroke gets you down to gut level to view C *and* assembly language.

It's what you should have been able to do from the beginning but couldn't until Arium Echo redefined microprocessor development systems in terms of performance and price. That's why, at $9980, this 16-bit, true multitasking, UNIX-compatible system delivers more power, more speed and more menu-driven features than the HP 64000 system costing four times as much. Features like on-screen time stamping, super high speed C and Pascal compilers, and Arium's Proprietary Code Preview™ that lets you see where your code is going, as well as where it's been.

Echo is a multi-user system; but so affordable, every engineer could have his own. No sharing, no waiting, no lost man-hours. Just all the resources you need at your fingertips. One call now to the Arium Hot Line, **(800) 862-7486,** will give you all the reasons why when it comes to performance and price, nobody echoes Echo. Not from the beginning. Not now. Not ever.



See Us at Electro '87 Booth 2844

ARIUM
CORPORATION

1931 Wright Circle
Anaheim, CA 92806
(714) 978-9531

CIRCLE NO 171

NEW BOOKS

Electromagnetic Compatibility Handbook, by J L Norman Violette, Donald R J White, and Michael F Violette. 707 pgs; $68.95; Van Nostrand Reinhold, New York, NY, 1986.

This handbook approaches in a practical way the problems involved in achieving electromagnetic compatibility in electrical or electronic systems. It considers the fundamental electromagnetic concepts, explains the causes and effects of electromagnetic interference, and discusses current EMI problem-solving techniques. The work offers solutions to the problems of how to identify EMI sources, quantify resultant ambient electromagnetic fields when possible, identify EMI receptors and quantitatively determine their susceptibility, and develop the most cost-effective ways to eliminate EMI.

Modern Acoustical Imaging, edited by Hua Lee and Glen Wade. 433 pgs; $51.95; IEEE Press, New York, NY, 1986.

Divided into eight sections, this book reviews the various developments in acoustical imaging. The editors have placed the material into eight categories: pulse-echo techniques, holography, tomography, microscopy, imaging systems in general, seismic exploration, signal analysis and processing, and image understanding. The 35 reprinted papers describe how sound can produce images of objects that can't be obtained using light, x-rays, or other types of radiation.

Probability, Signals, Noise, by Jacques Dupraz. 344 pgs; $39.95; McGraw-Hill Book Co, New York, NY, 1986.

With an emphasis on practical applications, this work provides a comprehensive treatment of signal theory and probability. Written for use as a textbook, it takes you from the standard concept of a random variable to the ideas of random vectors and signals. The fundamentals of probability theory are also covered. It has numerous exercises and examples to help you solve on-the-job signal and noise problems.

Magnetic Recording, Volume I: Technology, edited by C Denis Mee and Eric D Daniel. 514 pgs; $34.50; McGraw-Hill Book Co, New York, NY, 1986.

Volume I of this 2-volume set covers in depth the basic technology of magnetic recording. It provides material on longitudinal versus perpendicular recording, physical tolerance, noise constraints, head geometries and materials, reproduction techniques, linear and nonlinear recording, storage formats, substrates, particulate media, film media, head-media interface, and more. Volume II, which will cover the varied applications of magnetic recording, will be published in the fall.

The Theory of Fourier Series and Integrals, by P L Walker. 192 pgs; $29.95, John Wiley & Sons Inc, New York, NY, 1986.

After presenting a concise explanation of the theory of Fourier series and integrals, this books shows how you can apply that theory, with a minimum of mathematical knowledge, to a variety of areas of science and engineering. Included are examples, exercises, a bibliography, and a guide to further reading.

Handbook of Magnetic Phenomena, by Harry E Burke. 423 pgs; $49.50; Van Nostrand Reinhold, New York, NY, 1986.

This book applies the basics of Ampere's Law to advanced electromagnetic-field theory. Over 60 phenomena are discussed and illustrated. Among the magnetic fields covered are the Biot-Savart fields and torroidal fields. Also, the book fully classifies the galvanomagnetic effects. The author covers spinning electric charges, magnetic hysteresis, thermal effects, mechanical effects, magnetic-field measurement, and magnetic resonance.

Practical Digital Electronics, by Pierre Pelloso. 219 pgs; $29.95; John Wiley & Sons Inc, New York, NY, 1986.

To explain digital electronics in depth, this book begins each of its six chapters with a theoretical discussion and follows that with some practical problems and their solutions. The book focuses the design and realization of digital circuits and subsystems using small-, medium-, and large-scale integrated circuits. The author places emphasis on the avoidance of timing problems by the correct use of signals; interconnections and associated noise margins are investigated in detail. All the devices discussed are well known and readily available.

Be An Author!

When you write for EDN, you earn professional recognition. And you earn $75 per published magazine page.

EDN publishes how-to design application information that is read by more than 137,000 electronics engineers and engineering managers worldwide. That's an audience that could belong to you.

If you have an appropriate article idea, please phone Eva Freeman, Associate Editor, at (617) 964-3030, or send a proposal and outline to her at 275 Washington Street, Newton, MA 02158 –1630. For a FREE EDN Writer's Guide—which includes tips on how to write for EDN and other technical publications—please circle number 800 on the Information Retrieval Service Card.

EDN

First in Readership among Design Engineers and Engineering Managers in Electronics

VF Technology... The Bright Decision

Futaba, a world leading manufacturer of vacuum fluorescent displays, offers a wide assortment of *display tubes* in many sizes and formats. Also, Futaba offers *display modules* with all the electronics required to refresh the display and easily interface with the host system.

GRAPHIC DISPLAY

Both front glass phosphor, which provides maximum viewing angle and uniform surface appearance, and conventional back glass phosphor, with optimum brightness and software dimming capabilities, are available. All Futaba graphics modules offer complete drive electronics, bit mapped control with a DC/DC converter. All active components are surface mounted onto a single board.

DOT MATRIX MODULES

Utilizing Futaba's dot matrix displays, a completely intelligent line of "dot modules" is available. Each includes all drive, power supply and microprocessor components surface mounted onto a single board. Surface mounted technology results in higher reliability and allows for a smaller overall package and lower cost. All dot modules require only a 5V DC power source and can accept parallel or 8 possible serial baud rates.

GRAPHIC DISPLAYS/MODULES

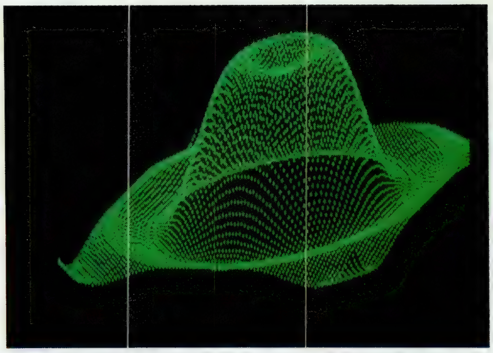
Futaba Display	Futaba Module	Pixels (Row X Char.)	Brightness (FT-L)	Module Dimensions (in.)
GP1005B	GP1005B03B	128X64	400	7.28X3.35X1.77
GP1006B	GP1006B04B	256X64	200	9.84X3.35X1.77
GP1009B	GP1009B03B	240X64	200	6.2X2.76X1.57
GP1010B	GP1010B01B	176X16	200	7.32X2.16X1.70
GP1002C	GP1002C02B	320X240	100*	7.10X6.30X1.60

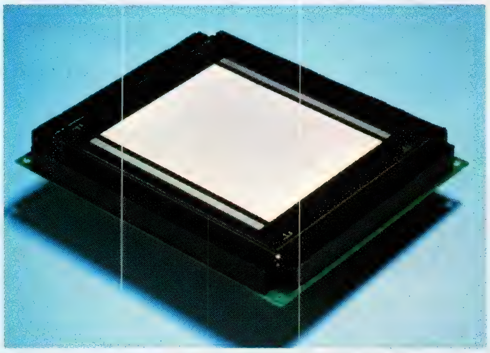
*Different Versions Available

DOT MATRIX DISPLAYS/MODULES

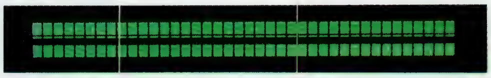
Futaba Display	Futaba Module	Char. X Row	Dot Format	Char. Ht. (in.)	Module Dimensions (in.)
20SD01Z	M20SD01CA	20X1	5X7	0.200	6.3X1.97X.75
20SD42Z	M20SD42CA	20X1	5X12	0.344	7.1X2.16X.88
40SD02Z	M40SD02CA	40X1	5X7	0.200	9.45X2.16X.88
40SD42Z	M40SD42CA	40X1	5X12	0.344	9.45X2.16X.88
202SD03Z	M202SD03CA	20X2	5X7	0.200	6.7X2.56X.90
402SD04Z	M402SD04CA	40X2	5X7	0.200	10.43X2.56X.90
MANY OTHER DISPLAYS	**NEW MODULES AVAILABLE SOON**				

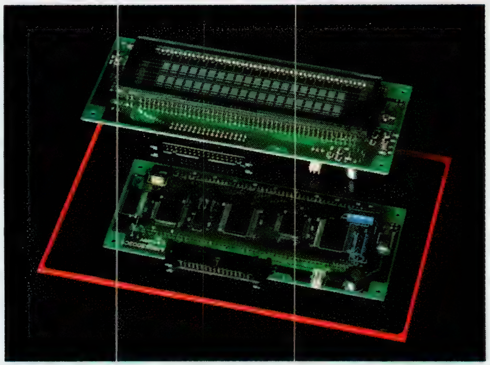
FUTABA
Corporation of America
Electronic Components Division
711 E. State Parkway, Schaumburg, IL 60195 • Telephone: (312) 884-1444 Telex: 206-833





Compact, flat panel graphic displays and modules present clean, sharp images, whether for text or full graphics application.





Pattern flexibility and pleasing appearance are offered by Futaba in dot displays and modules.

Futaba also offers a complete catalog of alphanumeric, segmented displays.

Futaba supports its products with design engineering and system integration assistance. Call or write today.

CIRCLE NO 166

Putting Creativity to work

Deborah Asbrand, *Associate Editor*

Author Betty Edwards is surprised that, although the subject of creativity is not a frequent topic of conversation, it's one of genuine importance to most people. "The question 'Am I creative?' is a burning one for many people," says Edwards, the author of *Drawing on the Right Side of the Brain* and *Drawing on the Artist Within.* "If I ask people if they want to be creative, the answer is overwhelmingly 'yes.' If I ask why, the answer is that being creative gives meaning to one's life."

> In the electronics sector, which prides itself as a bastion of innovation, the idea of using outsiders to assist in creative ventures has proved hard to sell.

Despite the high level of importance that people assign to creativity, however, many quickly dismiss their own potential for innovation, whether it's in the fine arts or in new-product design.

In fact, many people are scared away from even considering their creative potential because they believe some of the myths that have grown up around the creative process—for instance, that creativity is the exclusive province of people who are larger than life, that the mental pathways to creativity are neat and orderly, or that new products spring whole and finished from the creative mind. Other myths about the creative process have gone so far as to elevate it to the divine level.

A skill, not a gift

Yet many observers are now pointing out that the creative process isn't nearly as mysterious as it was once considered. Not only is creativity more of a skill than an innate gift, they say, but it's also a skill that most people can acquire. That idea has caught the interest of American business and has led to a rise in programs designed to stimulate latent creative potential, and, ultimately, spawn new and innovative products.

Moshe Rubenstein, professor of engineering and applied science at the University of California in Los Angeles and a speaker on the topic of creativity, scoffs at the veil of mystique that typically surrounds the creative process. Ideas, he says, are "nothing more than untested hypotheses." And the generation of ideas, particularly the creative problem solving in which engineers frequently engage, is often erratic. "The creative process in problem solving begins with chaos and then gives way to order," Rubenstein says. "Most ideas don't pan out at first. They need modification."

Rubenstein also discounts the theory that the best ideas are generated by individuals who are well versed in a particular subject. It's unnecessary to review large amounts of data on a problem before starting to hammer out ideas for solutions, he says, and companies with a penchant for doing so are actually restricting their employees' capacity for innovative thinking. Instead of letting their employees' imaginations fly based on a limited amount of information, the companies, by introducing voluminous reports and data, outline the parameters within which the employees' ideas must fall. "Ideas are generated based on fragments of information," Rubenstein says. "Sometimes too much information stifles the potential of surfacing ideas."

The freshest and least inhibited viewpoint probably produces the most novel solutions, Rubenstein says. At the conference "Fostering Creativity and Innovation," sponsored last December by the National Technological University, he demonstrated for the audience how restrictions in problem solving inhibit the generation of innovative ideas. Holding up a white page bearing a black inkblot, Rubenstein asked the audience to identify what they saw in the inkblot—their answers, though, he instructed, had to be three-letter words beginning with the letter "m."

"I'm putting a straitjacket on your creative thinking," Rubenstein explained. "Innovation begins with how you look at things. So not putting restraints on how you look at things is critical to creativity."

Research in creativity

The idea that creativity might be a skill anyone can learn rather than an innate gift has led to a surge of interest in learning more about the creative process. Although some individuals attribute their ideas or artistic expressions to divine inspiration, researchers say that most creative people simply exert greater control over their thought processes. As a result, they're able to direct their thoughts down innovative, imaginative paths.

Most information about creativity's organic origins is based on the groundbreaking research in the 1950s that found that each of the brain's hemispheres controls specific neural functions. The left hemisphere was discovered to control humans' logical and analytical thinking as well as their capacity for language; the right hemisphere controls visual and perceptual responses.

Thirty years later, scientific opinion on the brain's role in creativity falls into two camps: One group adheres to the conclusion that such functions as logic, analysis, and language reside in the left side of the brain and that visual and perceptual skills reside in the right side. The other group agrees that specific sections of the brain control specific neural functions, but believes that the brain is too complex an organ to divide its functions neatly by hemisphere.

What's clear is that creativity requires access to all of the brain's functions. Making the necessary neural transitions can be harder for some people than for others. Engineers, for example, depend largely on their talents for analysis and logical problem solving. They may be out of practice when it comes to tapping the abilities that lie in the portion of the brain that controls more artistic, less logical thinking. "Professionals need to think in a routine way 80 to 90% of the time," says Mark Sebell, a principal at Synectics, a Cambridge, MA, company that specializes in creativity and its management. "The glitch occurs when people try to use routine skills in an exploratory situation."

Synectics is one of a growing number of companies that work with corporations and their employees to improve their ability to open the stopper on imaginative thinking. The goal is to produce ideas for new ways of doing everything from designing new products to reorganizing the corporation.

Although client companies' first thoughts are usually to send their product manager, marketing manager, and marketing researchers to the sessions, Sebell says that Synectics has found the most productive groups to be ones whose members work at a variety of jobs. "You need to bring together a rich, diverse group of people who are going to look at problems in a new way." Often secretaries, sales people, accountants, and operations managers are included in the sessions.

> "Professionals need to think in a routine way 80 to 90% of the time. The glitch occurs when people try to use routine skills in an exploratory situation."

Program participants take mental "excursions," as Synectics calls them, in seemingly irrelevant directions that help those assembled make new associations. The interactions that occur among the group members are an important component of Synectics' version of the creative process. "One of the myths of creativity is that it's an individual thing," says Tom Crowe, the company's director of West Coast marketing. "But it comes out of group interaction." Once individuals become adept at connecting ideas and working together, they control their own creativity, Synectics' staff reasons.

Learning to "see"

Engineering students at California State University in Long Beach are learning a different kind of creative control from author Betty Edwards, who is a professor of art at the college. Edwards strongly supports the theory that tapping one's creative potential—whether it's in problem solving or in the fine arts—requires a shift of thinking from the left side of the brain to the right.

> "Ideas are generated based on fragments of information. Sometimes too much information stifles the potential of surfacing ideas."

In her drawing classes, Edwards teaches her students "how to control their own brain and develop perceptual skills through drawing." The class is more a lesson in "seeing" than in drawing, she says. To prove her point, Edwards shows drawings rendered by students before and after taking her class. Even those students whose preinstruction drawings were primitive and childlike improved after several weeks of instruction to the point where their drawings appeared to have been done by an artist of some skill.

California State's engineering students aren't required to take Edwards' class, but advisers strongly recommend the course as a complement to the students' engineering classwork. About 40% of Edwards' students are engineering majors. Those that enroll "let it be known that this is soft stuff compared to what they're used to," she says. Called upon to use their visual and perceptual skills, however, the engineering students discover how different such skills are from those they're accustomed to using. "They go through a period of bafflement because the problems are ones they don't know how to solve," Edwards says.

Although some students drop the class in frustration, most complete the course, and some return to tell Edwards how the "sight" training has helped them in their engineering. "Students say that they can now visualize problems to a larger extent and they can scan solutions without calculating all of them. They feel their thinking is more flexible," Edwards says.

The business community's rising interest in acquiring the same kind of expansive vision is evident in the growth of companies like Synectics, which now employs a staff of 50 to serve its 150 clients. Often, it is companies' misconceptions about the generation of new ideas, and the subsequent poor results, that send them looking for assistance, Sebell says. For example, some companies, hoping to put innovative products on the market, think they can simply order a batch from their design staff. Nothing stifles employees' creativity more quickly, says Sebell. "Creativity is a function of quality thinking and climate. Too few companies really foster the climate of innovation that they claim to stand for."

Synectics lists a long string of successes in the consumer sector. The company credits itself with assisting in the development of General Electric's line of Space Saver appliances, Sunoco's dial-your-own-octane gas pumps, and vandal-resistant pay telephones for New York Telephone. But in the electronics sector, which prides itself as a bastion of innovation, the idea of using outsiders to assist in creative ventures has proved much harder to sell.

"High-technology companies say to us, 'We've got enough creativity in our business,'" says Sebell. In addition to making the same creativity-related mistakes that consumer companies make, he says, high-technology companies have

Hughes surface mount connectors give you closer board-to-board mounting, densities to .025, and up to 15% more board space.

Off-board mounting makes the difference.

Greater reliability, too, with insertion/withdrawal forces transmitted to the board via mechanical fixing.

No mechanical loading on vulnerable solder joints, a weak link in ordinary surface mount connector installations.

Surface mount connectors available, off-the-shelf:

- Two-part PC connectors
- Card connectors
- Test connectors

Also our custom Gold Dot Interconnection System.

For more information, call Mike Howett, 714-660-5702.

In England call
Hugh McInally,
0932 47262.

HUGHES
AIRCRAFT COMPANY
CONNECTING DEVICES DIVISION
Industrial Electronics Group

CIRCLE NO 165

their own set of problems. "They don't listen well—to each other, to their employees, to the marketplace." But more companies are beginning to warm to the idea of creativity consultants. AT&T, Digital Equipment Corp, General Electric, IBM, Lotus Development, Wang Laboratories, and Westinghouse Electric are all clients of Synectics.

As the number of creativity consultants grows, some consultants are beginning to question the quality and effectiveness of learning sessions. The lasting value of such workshops can be difficult to gauge, says Edwards, who is herself a part-time consultant and workshop leader. "They're interesting, and they expose people to new ideas, but they're equivalent to a weekend retreat. If you didn't know how to read, and you spent a weekend learning, you'd come away with some knowledge of reading. But unless you practiced diligently on your own, you'd soon forget most of what you learned."

In addition to an individual's commitment to becoming skilled at putting creative powers to use, commitment is needed at the corporate level. Edwards says that despite companies' vocal support of creativity workshops and the processes that go along with them, few firms provide employees with either the time or the space they need to develop ideas. Rubenstein agrees: "We preach creativity, but we don't support it."

No matter how well a company plans, or how skillfully it thinks it can predict the future, Rubenstein cautions, "no one's crystal ball is without error." Giving more time to the development of new ideas, he says, is key to a company's success.

EDN

Article Interest Quotient
(Circle One)
High 518 Medium 519 Low 520

BUSINESS/CORPORATE STAFF

F Warren Dickson
Vice President/Publisher
Newton, MA 02158
(617) 964-3030
Telex 940573
Diann Siegel, Assistant

Peter D Coley
Associate Publisher/
Advertising Sales Director
Newton, MA 02158
(617) 964-3030
Stacey Vorias, Assistant

NEW ENGLAND
Bob Sommer, Regional Manager
199 Wells Ave
Newton, MA 02159
(617) 964-3730

STAMFORD 06904
George Isbell, Regional Manager
8 Stamford Forum, Box 10277
(203) 328-2580

ROSELAND, NJ 07068
Daniel J Rowland, Regional Manager
Chris Platt, Regional Manager
103 Eisenhower Parkway
(201) 228-8619
(201) 228-8620

PHILADELPHIA AREA
Steve Farkas, Regional Manager
999 Old Eagle School Rd
Wayne, PA 19087
(215) 293-1212

CHICAGO AREA
Clayton Ryder, Regional Manager
Randolph D King, Regional Manager
Cahners Plaza
1350 E Touhy Ave, Box 5080
Des Plaines, IL 60018
(312) 635-8800

DENVER 80206
John Huff, Regional Manager
270 St Paul St
(303) 388-4511

DALLAS 75234
Don Ward, Regional Manager
13740 Midway, Suite 515
(214) 980-0318

SAN JOSE 95128
Walt Patstone, Regional Manager
Bill Klanke, Regional Manager
Philip J Branon, Regional Manager
Mark Holdreith, Regional Manager
3031 Tisch Way, Suite 100
(408) 243-8838

LOS ANGELES 90064
Charles J Stillman, Jr
Regional Manager
12233 W Olympic Blvd
(213) 826-5818

ORANGE COUNTY/
SAN DIEGO 92715
Jim McErlean, Regional Manager
18818 Teller Ave, Suite 170
Irvine, CA
(714) 851-9422

PORTLAND, OREGON 97221
Pat Dakin, Regional Manager
Walt Patstone, Regional Manager
1750 SW Skyline Blvd, Box 6
(503) 297-3382

UNITED KINGDOM,
THE NETHERLANDS,
SCANDINAVIA
Jan Dawson, Regional Manager
39A Bowling Green Lane
London EC/1R/OBJ UK
44-1-278-2152
Telex: 28339

BELGIUM/FRANCE
Robert Broekman
American Publishers Representatives
4 Rue Robert de Flers
75015 Paris, France
33-1-46099595
Telex: 270560

GERMANY/SWITZERLAND
Wolfgang Richter
Sudring 53
7240 Horb/Neckar
West Germany
49-7451-7828; TX: 765450

AUSTRIA
Igal Elan
Elan Marketing Group
Neutor g 2, Box 84
1013 Vienna, Austria
43222-663012, 638461

SOUTHERN EUROPE
Igal Elan
Elan Marketing Group
13 Haifa St, Box 33439
Tel-Aviv, Israel
Tel: 972-3-268020
TX: 341667

FAR EAST
Ed Schrader, General Manager
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422; Telex: 183653

TOKYO 160
Kaoru Hara
Dynaco International Inc
Suite 1003, Sun-Palace Shinjuku
8-12-1 Nishishinjuku, Shinjuku-ku
Tokyo 160, Japan
Tel: (03) 366-8301
Telex: J2322609 DYNACO

TAIWAN
Owen Wang, Gen Mgr
Ace Marketing Inc
Box 26-578 Taipei, Taiwan
Republic of China
86-2-703-4272
Telex: 14142

KOREA
Korea Media Inc
Rm 110, A-11 Bldg 49-4,
Hoihyundong 2-Ka, Chung-Ku
CPO Box 2314, Seoul, Korea
Tel: 82-2-755-9880
Telex: K26249

SINGAPORE
Cheny Tan Associates
1 Goldhill Plaza
No 02-01
Newton Rd
Singapore 1130
Tel: 2549522
Telex: RS 35983 CTAL

PRODUCT MART
Joanne Dorian, Manager
475 Park Avenue South
New York, NY 10016
(212) 576-8015

CAREER OPPORTUNITIES/
CAREER NEWS
Roberta Renard
National Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8602

Janet O Penn
Eastern Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8610

Dan Brink
Western Sales Manager
2041 Business Center Dr
Suite 109
Irvine, CA 92715
(714) 851-9422

Diann Siegel
Boston Sales Representative
Newton, MA 02158
(617) 964-3030

Maria Cubas
Production Assistant
(201) 228-8608

Cahners Magazine Division
William Platt, President
Terry McDermott, Executive Vice President
Frank Sibley, Group Vice President
Tom Dellamaria, VP/Production & Manufacturing

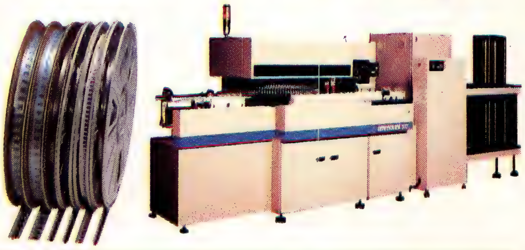
Circulation
Denver, CO: (303) 388-4511
Sherri Gronli, Group Manager
Eric Schmierer, Manager

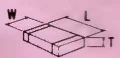
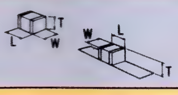
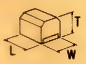
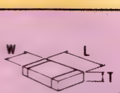
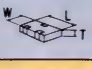
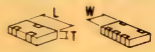
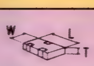
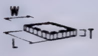
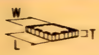
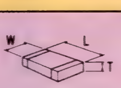
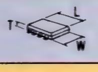
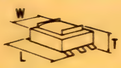
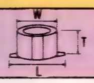
Reprints of EDN articles are available on a custom printing basis at reasonable prices in quantities of 500 or more. For an exact quote, contact Joanne R Westphal, Cahners Reprint Service, Cahners Plaza, 1350 E Touhy Ave, Box 5080, Des Plaines, IL 60018. Phone (312) 635-8800.

In Surface Mountable Components, TDK Quality Is More Than Skin Deep.

As boards are getting thinner, TDK is helping that diet succeed by providing a variety of extra-slim surface mountable components. Nourished by TDK's expertise in ferrite and ceramic materials, these miniaturized components feed on TDK—developed multi-layerization and multi-functionalism.

How do we know the exact needs of high-quality automated board production? Well, a fair share of the world's automatic mounting equipment —the Avimount series—comes from TDK.



Product name		Type	Shape	Dimensions			Electrical Characteristics
				L (mm)	W (mm)	T (mm)	
Multilayer Ceramic Chip Capacitor		C1508		1.5	0.8	1.0	C: 0.5~470pF, 100~22,000pF
		C2012		2.0	1.25	0.6 0.85 1.25	C: 0.5~1,800pF C: 470~100,000pF
		C3216		3.2	1.6	0.6 0.85 1.1	C: 0.5~270pF C: 470~220,000pF
		C3225		3.2	2.5	< 1.9	C: 750~8,200pF, 56,000~470,000pF
		C4532		4.5	3.2	< 1.9	C: 2,400~18,000pF, 180,000pF~1μF
		C5650		5.6	5.0	< 1.9	C: 5,100~33,000pF, 270,000pF~1.5μF
Multilayer Ceramic Chip Capacitor (High Frequency, Low Loss)		FC1414		1.4	1.4	1.6	C: 0.5~100pF, 150~3,300pF
		FC2828		2.8	2.8	2.8	C: 0.5~1,000pF, 470~22,000pF
		FR1414		1.4	1.4	1.6	C: 0.5~100pF, 150~3,300pF
		FR2828		2.8	2.8	2.8	C: 0.5~1,000pF, 470~22,000pF
Leadless Inductor (Wound Chip Inductor)		NL322522		3.2	2.5	2.2	L: 0.01~220μH
		NL453232		4.5	3.2	3.2	L: 1.0~1,000μH
		NL565050		5.6	5.0	5.0	L: 1,200~10,000μH
		NLF453232		4.5	3.2	3.2	L: 1.0~1,000μH (Shielded Inductor)
Multilayer Chip Inductor		MLF3216		3.2	1.6	0.6 1.1	L:0.047~220μH
		MLF3225		3.2	2.5	1.1 1.8 2.5	
Multilayer Chip Transformer		MTT4532		4.5	3.2	2.8 max.	L: 10~200μH
Multilayer Chip IFT		MIA4532		4.5	3.2	2.8	F:455, 459, 464kHz
		MIF4532		4.5	3.2	2.2	F: 10.7MHz
Multilayer Chip LC Trap		MXT4532		4.5	3.2	2.8 max.	F: fo ±2%
Multilayer Chip LC Filter	HPF (Tuner)	MXF4532H		4.5	3.2	2.8 max.	Electrical characteristics are representative, please specify value when ordering.
	BPF (FM radio)	MXF4532B		4.5	3.2	2.8 max.	
	BPF (VCR)	MXB5050B		5.0	5.0	2.8 max.	
	LPF (VCR)	MXB5050L		5.0	5.0	2.8 max.	
	Equalizer (VCR)	MXB5050E		5.0	5.0	2.8 max.	
	Delay Line (VCR)	MXB5050D		5.0	5.0	2.8 max.	
Multilayer Chip Capacitor Network		MCN7575		7.5	7.5	0.9	C: 1~1,000pF (TC:CH) (10 capacitors) C:10~1,000pF (TC:SL) (10 capacitors)
Ferrite Chip Beads		CB201209		2.0	1,25	0.9	Zo: 7, 10, 11Ω
		CB321611		3.2	1.6	1.1	Zo: 19, 26, 31Ω
		CB322513		3.2	2.5	1.3	Zo: 31, 52, 60Ω
		CB453215		4.5	3.2	1.5	Zo: 70, 120, 125Ω
SM Active Delay Line		FDL		12.0	9.5	5.6	Delay time: 20~250 nsec.
SM Transformer/ Inductor		EE5		7.4	5.3	4.75	Electrical characteristics are representative, please specify value when ordering.
		ER9.5		11.5	9.5	6.3	
		ER11		12.5	11.0	6.3	
		T2		7.0	5.0	2.2	
SMD Step-up Inductor (Piezoelectric Buzzer)		OL3.3×1.6		5.6	5.3	1.6	Inductance values are representative, please specify value when ordering.
		OL3.3×2.1		5.6	3.3	2.1	

See our Chip Components and other fine products at Electro/87 April 7-9, Jacob K. Javits Convention Center New York. TDK Booth No. 2672.

TDK®

Electro/87

TDK CORPORATION OF AMERICA HEAD OFFICE 4711 West Golf Road, Skokie, IL 60076, U.S.A. Phone: (312) 679-8200 CHICAGO REGIONAL OFFICE Phone: (312) 679-8200 LOS ANGELES REGIONAL OFFICE Phone: (213) 539-6631 INDIANAPOLIS REGIONAL OFFICE Phone: (317) 872-0370 NEW YORK REGIONAL OFFICE Phone: (516) 625-0100 SAN FRANCISCO DISTRICT OFFICE Phone: (408) 435-8565 DETROIT DISTRICT OFFICE Phone: (313) 353-9393 HUNTSVILLE DISTRICT OFFICE Phone: (205) 539-4551 GREENSBORO DISTRICT OFFICE Phone: (919) 292-0012 DALLAS DISTRICT OFFICE Phone: (214) 506-9800 NEW JERSEY DISTRICT OFFICE Phone: (201) 736-0023 **TDK CORPORATION.** TOKYO, JAPAN.

CIRCLE NO 164

CAREER OPPORTUNITIES

1987 Editorial Calendar and Planning Guide

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN News
Apr. 15	Mar. 26	Microprocessor Technology; Software Development; Digital ICs	Closing: Apr. 2 Mailing: Apr. 23
Apr. 30	Apr. 9	Communications Special Issue; ASICs; Test & Measurement	
May 14	Apr. 23	Analog Technology Special Issue; ICs; Test & Measurement	Closing: Apr. 30 Mailing: May 21
May 28	May 7	Computer Peripherals; Software; Power Sources/Devices	
June 11	May 21	Math ICs; CAE; Computers	Closing: May 28 Mailing: June 18
June 25	June 4	ASIC (Semicustom ICs) Directory; Analog ICs; Surface-Mount Technology	
July 9	June 18	Product Showcase-Volume 1; ICs & Semiconductors; Software	Closing: June 25 Mailing: July 16
July 23	July 2	Product Showcase-Volume II; Computers & Peripherals; Test & Measurement Instruments	
Aug. 6	July 16	Computer Boards; Digital Signal Processing; Test & Measurement; Top Ten Reader Vote Contest	Closing: July 23 Mailing: Aug. 13
Aug. 20	July 30	Military Electronics Special Issue; Fiberoptics; Software	

Call today for information.

East Coast Janet O. Penn (201) 228-8610
West Coast Dan Brink (714) 851-9422
National Roberta Renard (201) 228-8602

ISC

ISC Aerospace, Inc., Research and Development Center, a leader in tactical weapon technology applications, is looking for a few good people to join our high tech, high energy, entrepreneurial organization. Located north of Los Angeles in beautiful Westlake Village, we offer challenges equal to your talent.

ISC Aerospace, Inc.

PROJECT ENGINEERS—SYSTEM TEST

Design and development of test equipment for electro-optic weapon and seeker systems including PC Based tests. Requires degree and six to ten years experience.

SOFTWARE DESIGN ENGINEERS

Software design involving microprocessor based programming (C, PL/M, assembly language). Tactical weapon control software and IBM PC Experience preferred. Requires degree and two to ten years experience.

ANALOG DESIGN ENGINEERS

Concept to completion design, analysis, and testing of analog circuitry including signal processing, pre-amps, and phase locked loops. Video signal processing desirable. Requires degree and three years experience.

DIGITAL DESIGN ENGINEERS

Concept to completion design, analysis and testing of digital circuits including discrete component design, finite state machines, PALS, Gate Arrays, TTL, ECL, and CMOS. Requires degree and minimum three years experience.

Must be U.S. Citizen

Please submit resume, along with salary history to:
Personnel Administrator
ISC AEROSPACE, INC.
Research and Development Center
5703 Corsa Ave.—Box M
Westlake Village, CA 91362
Equal Opportunity Employer

ISC

---

* * * * * * * * * * * * * * *

DESIGN ENGINEER

Transformers

Chicago based manufacturer is seeking an experienced design engineer for linear, ferroresonant, high frequency, and telecommunication transformers. Some knowledge of power supplies is preferred but not required. Reply to:

Mr. Roger Hilderbrand

MIDWESTCO
Enterprises, Inc.,

2735 North Ashland Ave.
Chicago, IL 60614

* * * * * * * * * * * * * * *

WE HAVE YOUR NEXT POSITION.

NATIONWIDE OPPORTUNITIES

- HARDWARE
- SOFTWARE
- DEFENSE ELECTRONICS
- AEROSPACE SYSTEMS
- COMMUNICATIONS SYSTEMS
- CAD/CAM

JAMES E. IANNONI
& ASSOCIATES

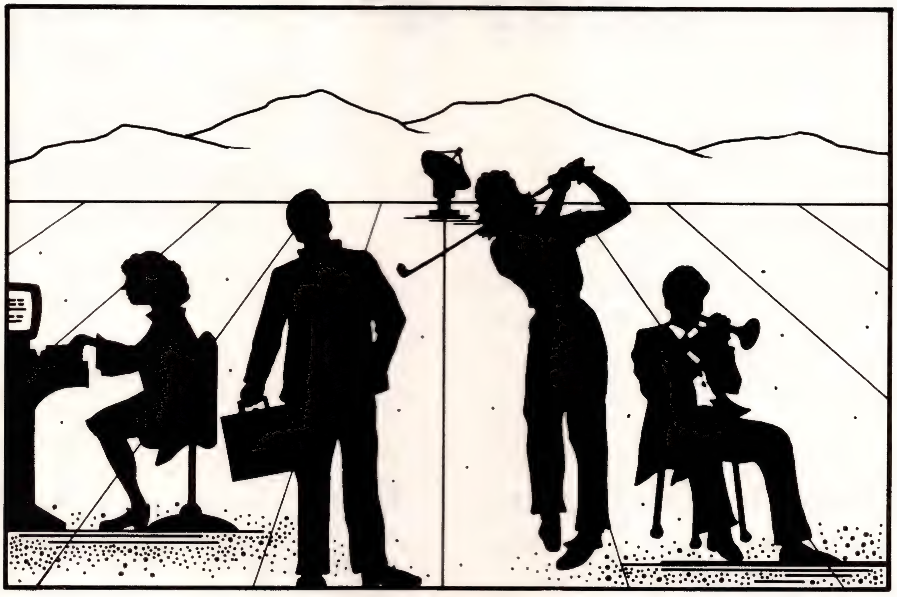
P.O. Box 128 • Canterbury, CT
06331 • (203) 546-9448

Client companies assume all fees.

EDN

First in Readership Among Design Engineers and Engineering Managers in Electronics

More than you ever expected



and a free trip to Las Vegas!

. . . where annual gaming revenues total $2 billion, and **DEFENSE SPENDING APPROACHES $3 BILLION . . .**

. . . where major resorts host more than 14 million visitors each year while nearby some of the world's **MOST ADVANCED TECHNOLOGY IS BEING DEVELOPED . . .**

. . . where even the largest hotel cannot rival the employment provided by **NELLIS AFB**, the **LARGEST BASE** in the **TACTICAL AIR COMMAND** and **NEVADA'S LARGEST SINGLE EMPLOYER . . .**

. . . and where Southern Nevada's **FLAWLESS CLIMATE . . . ABUNDANT RECREATION . . . NO STATE INCOME TAX . . . LOW COST OF LIVING . . .** and **HIGH QUALITY OF LIFE** combine to make Las Vegas one of the **TOP 5 FASTEST GROWING METRO AREAS IN THE U.S.!**

If you have the skills we are seeking, you will be selected to visit us in Las Vegas and discuss your future on the cutting edge of technology.

SR. PROGRAM MANAGERS: Advanced Degree. Ten plus years experience in setting up and managing formal DOD Engineering Programs for design and development of RF and Microwave systems. Background should include WBS development, compliance to MIL Spec, configuration management, and coordination of program support functions. Specify position code 3-EDN 3-7.

SR. RF/SYSTEMS ENGINEERS: Advanced Degree. Ten plus years experience in military RF and microwave analysis, design, and implementation. Ground based radar system experience desirable. Specify position code 1-EDN 3-7.

SR. DIGITAL ENGINEERS: Advanced Degree. Ten plus years experience in signal processing, analysis, design, implementation, and data collection systems. System level and detailed knowledge of microprocessor hardware, firmware, and BUS architectures. Familiarity with radar systems desirable. Specify position code 2-EDN 3-7.

EG&G

An Equal Opportunity Employer
U.S. Citizenship Required

Submit Resume Specifying Position Codes to:
EG&G Special Projects, Inc.
Attn: Jack Pollock, Recruiter
P.O. Box 15110
Las Vegas, Nevada 89114
(702) 369-3000

Honeywell in Albuquerque:

Engineers

Sperry's Defense Systems Division in Albuquerque has become a part of Honeywell, Inc. The combination of Sperry and Honeywell aerospace operations creates a stronger market force, offering more products and systems for military aviation and more opportunities for career growth.

Power Supply Engineer

You will assist project groups in the analysis and design of low- and high-voltage power supplies for high reliability applications. A working knowledge of MIL-STD-704 and power FET switchmode conversion circuitry plus four year's experience and a BSEE degree is essential.

Electronic Packaging Engineer

This position will require coordination of customer requirements, packaging concepts, analysis, manufacturing processes and tests to achieve a viable product. Requires a BSME and a minimum of two year's experience with military airborne or space electronic equipment.

Reliability Engineer

In this position you will perform circuit stress analysis, reliability prediction and failure mode analysis and participate in reliability development testing. A BSEE degree and two or more year's experience is required.

Components Engineer

In this position you will prepare component specifications and provide technical liaison between Sperry Aerospace and component vendors. We need people who are specialists in electrical, electronic and mechanical components. A BS degree in engineering or one of the physical sciences is required.

ATE Engineer

To qualify for this position you should have four or more year's experience in hardware and software design of test equipment. A BSEE/CE degree and experience in PASCAL is required.

For consideration, send your resume and salary information, in confidence, to Eric Gierschick, (EDN-E614B), Honeywell Inc., Sperry Defense Systems Division, P.O. Box 9200, Albuquerque, NM 87119.

Together, we can find the answers.

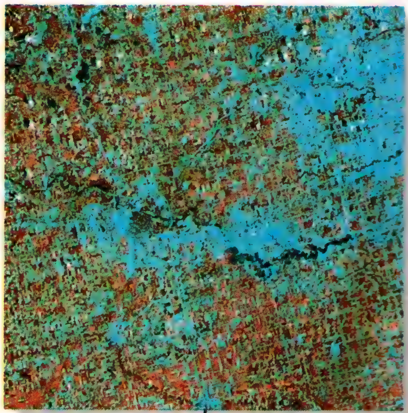
Honeywell

Equal Employment Opportunity/Affirmative Action Employer
U.S. citizenship is required

ERIM REPORT #7a

ERIM's Distributed Technology

ERIM's Ann Arbor headquarters is home for a majority of our 700 staff members. This research and development facility contains electronic, measurement, and fabrication laboratories, computer facilities, workshops, and offices.

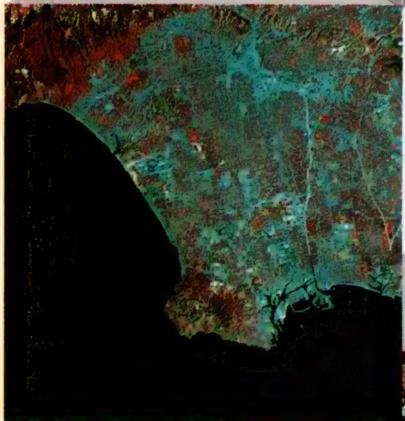


Our Flight Facility at Willow Run Airport houses two aircraft instrumented to pursue sensor research. It is equipped with everything necessary to operate, modify, and maintain the aircraft and to operate airborne sensor equipment.

The Institute operates a number of offices around the country, each with staff and programs customized for the sponsors in its area.

Los Angeles, California

Like the other ERIM offices, the Los Angeles facility was established to provide quick reaction and on-site technical support to sponsors on the West Coast. The office specializes in systems engineering, sensor applications analysis and development, digital signal processing, and systems performance analysis.



The backgrounds of staff members in Los Angeles span the engineering disciplines, with concentrations in electrical engineering, electro-optical and radar engineering, signal processing, and computer science.

Dayton, Ohio

Recently, ERIM established its newest office in Dayton, Ohio. This facility exists to support the Institute's programs with the Aeronautical Systems Division, the Air Force Wright Aeronautical Laboratories, and the Foreign Technology Division at Wright-Patterson Air Force Base.

Its mission is to provide sponsors with quick reaction in terms of technical expertise and support for programs dealing with synthetic aperture radar, electro-optics, and image and data processing systems. Staffing is currently in progress to support these technical areas.

Washington, DC

The largest of ERIM's branch locations is in Arlington, Virginia where about 40 staff members provide technical support to and liaison with sponsors in the Washington area. The office also offers general technical support to all Institute programs in addition to performing work on its own contracts.

While work at the facility covers the entire spectrum of Institute activities, there is a concentration on the interpretation and exploitation of synthetic aperture radar data with a special emphasis on human factors involved in information extraction.

Technical staff at the Washington office consists primarily of engineers and other physical scientists; other disciplines include mathematics, human factors engineering, and image and intelligence analysis.

Niceville, Florida

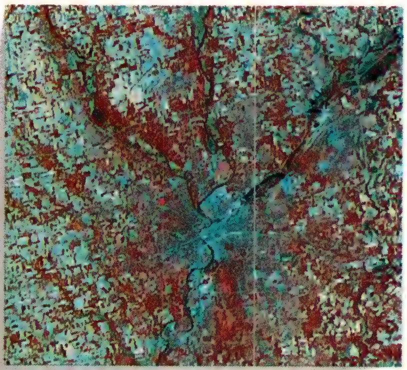
ERIM's Florida office was established in 1986 to help the Institute expand its customer base and technical horizons by moving into areas such as millimeter wave radar and imaging sonar. Intelligent weapons technology is a major focus, both in basic concepts and applications research, as well as systems development.

Staffing is currently underway. Areas of interest include millimeter wave radar, electro-optics, imaging sonar, and computer science/analysis.

Career Opportunities

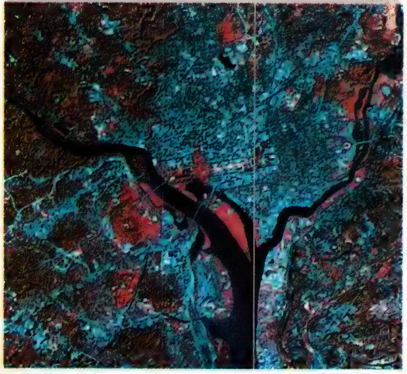
ERIM has research and management positions available at several levels in the following areas:

- **Radar System Design**
- **E-O/IR System Design and Analysis**
- **Computer Vision**
- **Optical Computer System**
- **Phase Retrieval/Signal Reconstruction**



- **Radar System Engineering and Analysis**
- **Signal and Image Processing**
- **Microwave Scattering and Measurement Engineering**
- **Diffractive Optics**

All positions require a BS, MS, or PhD in engineering, physics, mathematics, or statistics, along with appropriate work experience. Salary and benefits are highly competitive.



For details, telephone (313) 994-1200, ext. 3260. Or send your resume to Personnel Administrator, Dept. ED, ERIM, P.O. Box 8618, Ann Arbor, MI 48107-8618.

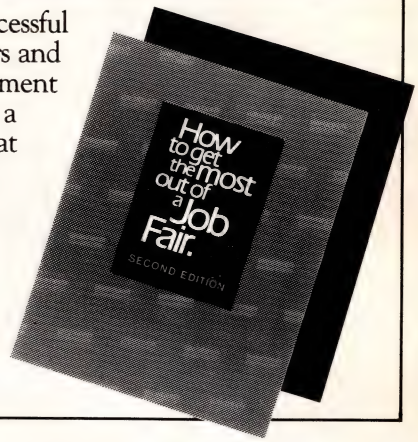
ERIM

U.S. Citizenship required/Equal opportunity employer

ARE YOU HUNTING FOR THE RIGHT PEOPLE IN ALL THE WRONG PLACES?

Over the years we've earned a reputation for developing successful job fairs — and for being the one-stop job hunt for engineers and computer professionals. Now you can maximize your recruitment efforts with our free booklet, "How to Get the Most Out of a Job Fair." You'll receive tips on how to be in the right place at the right time...for the right applicants. How to develop an effective recruitment strategy for an event and evaluate the results. And how to select the right job fair company and location for your hiring needs.

Share our expertise for free. Just call (408) 970-8800 — or write to Westech ExpoCorp, 4701 Patrick Henry Dr., #1901, Santa Clara, CA 95054.



Engineers and software/computer professionals look to Westech for career opportunities.

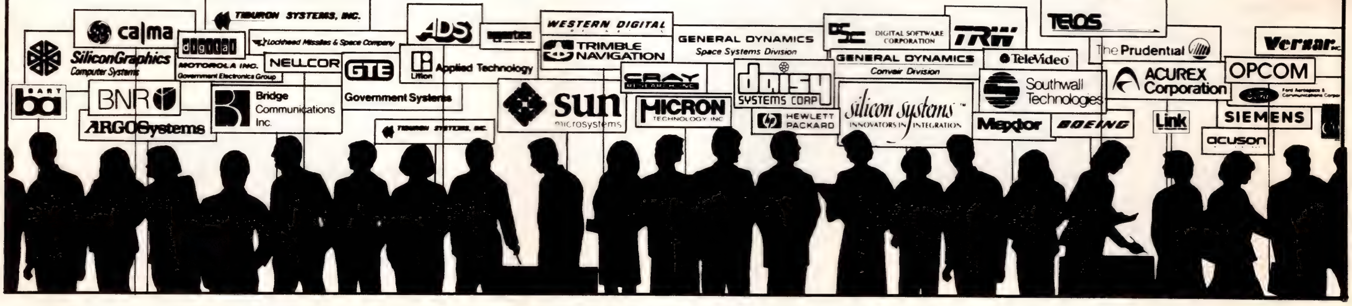
1987 Schedule

DALLAS, TX: Feb. 23 & 24
LONG BEACH, CA: Mar. 6 & 7
SAN DIEGO, CA: Mar. 16 & 17
AUSTIN, TX: Mar. 23 & 24
DENVER, CO: Apr. 6 & 7
SANTA CLARA, CA: Apr. 13 & 14
LOS ANGELES, CA: May 4 & 5
PHOENIX, AZ: May 18 & 19
SEATTLE, WA: Jun. 1 & 2
SANTA CLARA, CA: Jun. 15 & 16
DALLAS, TX: Jun. 29 & 30
SAN DIEGO, CA: Jul. 6 & 7
LONG BEACH, CA: Jul. 17 & 18
DENVER, CO: Aug. 3 & 4
SANTA CLARA, CA: Aug. 17 & 18
PHOENIX, AZ: Aug. 31 & Sept. 1
LOS ANGELES, CA: Sept. 14 & 15
AUSTIN, TX: Sept. 21 & 22
SEATTLE, WA: Sept. 28 & 29
SANTA CLARA, CA: Oct. 19 & 20
DALLAS, TX: Nov. 2 & 3
LONG BEACH, CA: Nov. 13 & 14
SANTA CLARA, CA: Dec. 7 & 8

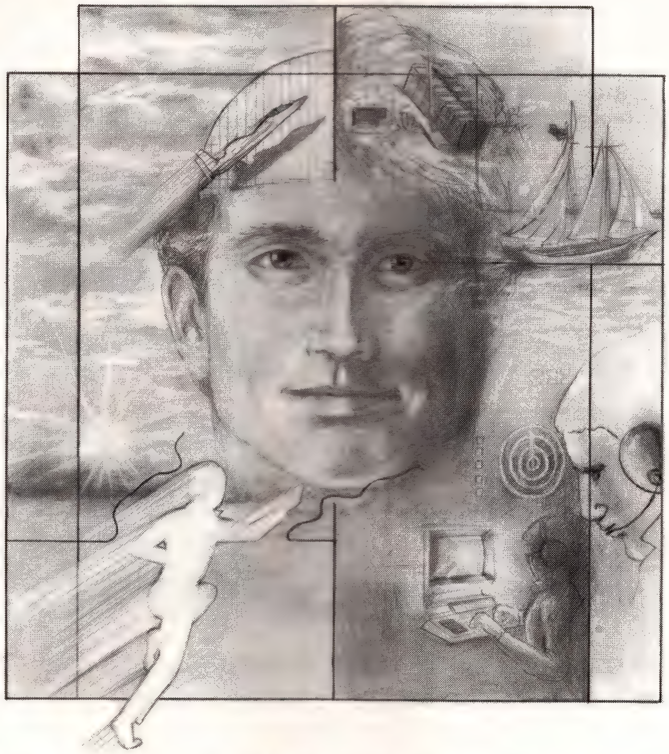
CAREER EXPO

Westech 87

QUALITY ATTRACTS QUALITY


calma
TIBURON SYSTEMS, INC.
digital
Lockheed Missiles & Space Company
SiliconGraphics Computer Systems
MOTOROLA INC. Government Electronics Group
NELLCOR
GTE
Litton Applied Technology
ADS
WESTERN DIGITAL
TRIMBLE NAVIGATION
GENERAL DYNAMICS Space Systems Division
DSC DIGITAL SOFTWARE CORPORATION
TRW
TELOS
The Prudential
Versar Inc
GENERAL DYNAMICS Convair Division
TeleVideo
CRAY
daisy SYSTEMS CORP
HEWLETT PACKARD
silicon systems INNOVATORS IN INTEGRATION
Southwall Technologies
ACUREX Corporation
OPCOM
Ford Aerospace & Communications Corporation
BART
BNR
Bridge Communications Inc.
Government Systems
sun microsystems
MICRON TECHNOLOGY INC
Maxtor
BOEING
Link
SIEMENS
acuson
ARGOSystems
TIBURON SYSTEMS, INC.

Technical Excellence



Our Greatest Achievement Unlocks Your Greatest Potential.

For over 60 years, Raytheon has been recognized as an authoritative source of technological innovation and excellence. Today, our Missile Systems Division continues the tradition of excellence with technical involvement deep enough to create advanced, workable, comprehensive engineering solutions; broad enough to encompass practically every discipline in electronics research, design, development, and production; and high enough to provide each of our talented technical professionals to determine tomorrow's state-of-the-art.

That's why the Missile Systems Division of Fortune-100 Raytheon is the ideal environment to develop your potential to its fullest and discover the important contribution you can make to the technology of your choice for some of the world's most important air defense systems.

Located in the center of technological innovation and excellence of the Route 128 area and only minutes from the unmatched educational, cultural, and recreational resources of Boston, Raytheon's Missile Systems Division also offers access to the exceptional quality of life of Massachusetts and the entire New England Region.

Raytheon: technical diversity and excellence that first unlocks potential . . . and then opens an extraordinary number of doors to success.

Current opportunities exist for qualified engineers in the following applications:
☐ RF/Microwave Systems Design ☐ Digital Systems Design ☐ Real-Time Software Systems Design ☐ Guidance and Control Design ☐ Test Systems Design ☐ Radar Systems ☐ Reliability/Quality Assurance ☐ Electro-Optics Design ☐ Missile Guidance Design

Engineering positions require a minimum BS degree in Electrical or Computer Engineering, Physics or Mathematics and at least 3–5 years' experience with real-time command and control systems, radars, missile guidance and digital equipment.

Raytheon offers excellent salaries and many company-paid benefits as well as Investment Plans and liberal relocation assistance. Please send resume with salary requirements to:
Stephen E. King, Raytheon Company, Missile Systems Division, Hartwell Rd., Bedford, MA 01730. U.S. Citizenship required. An Equal Opportunity Employer.

Raytheon

Where quality starts with fundamentals.

YOUR NEXT JOB IS ON THE LINE.

Whether you're just a little curious or actively pursuing a new job, you'll find what you're looking for on-line with BPI AdLine.™ The new, convenient way for you to communicate with high tech employers via computer. Just call up BPI AdLine™ on your PC or terminal, at home or work, at your leisure. The service is free and operates around the clock – 24 hours a day.

Once you're on-line, explore Fortune 1000 companies; their job openings, employee benefits, corporate facilities and much more company related information. You can even enter your resume into the system and rest assured it will be in the right hands, right away.

BPI AdLine™ is designed for you, the experienced technical professional. It's easy. It's quick. And it's completely confidential. BPI AdLine™ is the convenient way for you to explore your professional potential and discover the job that awaits you... on the line. *Companies are continuously added to the system. Please check regularly for updates.*

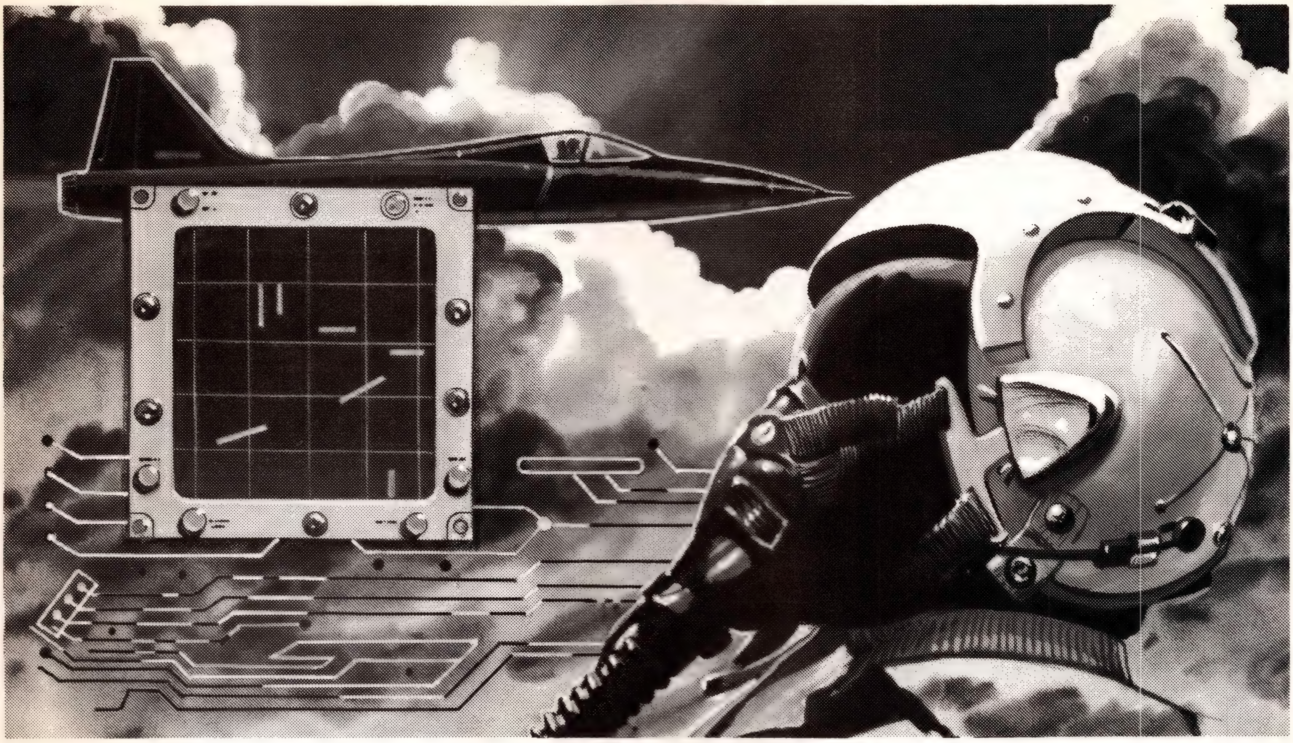
Created by the same people who bring you the original BPI TECH FAIRS. You can also use BPI AdLine™ to check on dates, times and locations of upcoming TECH FAIRS in your area.

How to get on-line with BPI AdLine™
DIAL 612-941-3957
on your PC or terminal
ENTER the password "BPI"

BPI AdLine™

"We are not an employment agency."

Business People Inc., 100 North Seventh Street, Minneapolis, MN 55403
612-370-0550



Engineering Opportunities with Emerson Electric's Government and Defense Group

- **RADAR SYSTEMS ENGINEERS (New Business)**
- **RADAR SYSTEMS ENGINEERS (On-Going Projects)**
- **ATE ENGINEERS (New Business)**
- **RELIABILITY/MAINTAINABILITY ENGINEERS**
- **ENVIRONMENTAL TEST ENGINEERS**
- **TFD/TRD ENGINEERS**

We are looking for a select group of professionals to work on major government and defense contracts awarded to Emerson Electric. Diverse projects are available for individuals who meet or exceed our professional and educational standards. All disciplines listed will work out of our facility in St. Louis. Candidates considered qualified must have a BSEE, BSEET, BSCS degree or higher, as specified.

RADAR SYSTEMS ENGINEERS (New Business)
Systems Engineers with Ground Radar or Airborne Radar systems experience will pursue new business development opportunities. Develop concepts functional requirements and system specifications for all elements of radar including processors, antenna, transmitters and displays. Prepare and present technical presentations (both internal and external). Interface with customers to assess requirements and provide technical solutions for customer needs. Lead and manage technical proposal preparations and internal CRAD/IRAD programs.

RADAR SYSTEMS ENGINEERS (On-Going Projects)
Provide system analysis, performance tracking, integration, and test of terrain following radar systems. Interface with customer and provide flight test support of installed radar system.

Minimum of 10 years or more experience in radar systems is required. Specific experience in the areas of coherent airborne radar TF/TA, or millimeter wave radar is highly desired. Minimum BSEE physics or math background required and MSEE desired.

ATE ENGINEERS (New Business)
Systems level engineers with background in ATE to prepare and present technical presentations to customers.

Requires minimum of 8 years experience in design and development and/or engineering management of test equipment systems with emphasis in RF and Digital.

RELIABILITY/MAINTAINABILITY ENGINEERS
Perform reliability and maintainability related analysis of electronic and mechanical systems. Prepare proposal and program plan inputs. Interface with design, components, failure analysis, logistics, and test engineering personnel.

Requires minimum of 2 to 7 years electronic circuit analysis and preparation of reliability related analysis. Must be familiar with reliability and maintainability MIL-Specs and program requirements.

ENVIRONMENTAL TEST ENGINEERS
Perform environmental and functional test planning, preparation, conduct tests; design of test fixtures and test setups, writing plans, reports; lead responsibility for test programs.

Ten years minimum experience performing tests including vibration, shock, temperature, humidity, altitude, EMI per MIL-Specs with formal documentation, familiar with test equipment, analog, digital, RF Systems.

TFD/TRD ENGINEERS
Prepare Test Requirement Documents (TRD's) and Test Flow Diagrams (TFD's) describing the detailed procedure for the test of various analog, digital, microprocessor and radio frequency (RF) boards and systems.

Requires one year minimum experience preparing detailed flowcharts that includes the necessary power and stimuli to be applied, sequence of application and the expected outputs to verify the performance of the circuitry. Also requires the ability to expand the performance flowchart to include diagnostic paths to isolate faulty circuitry to the component level.

Compensation is commensurate with your credentials and includes competitive fringe benefits. For prompt consideration, send your confidential resume or call our TOLL-FREE number 1-800-325-0783. Al Kaste, Mail Station 4335, Dept. EDN, Electronics and Space Division, EMERSON ELECTRIC CO., 8100 W. Florissant Avenue, St. Louis, MO 63136.

An equal opportunity employer. U.S. citizenship is required.

EMERSON ELECTRIC CO.
Electronics & Space Division

ADVERTISERS INDEX

Abbott—Power Supply Div ... 131
ACCELTechnologies Inc ... 265
Adaptec Inc ... 40-41
Advanced Microcomputer Systems Inc ... 150
Advanced Micro Devices ... 12-13
Alco Electronic Products Inc ... 269
Allied Electronics ... 109
Amco Engineering ... 220-221
American Photonics Inc ... 42
American Research and Engineering ... 115
AMP Inc ... 158-159
Amperex Electronic Corp ... 207
Antex Electronics ... 190
Antona Corp ... 265
Applied Microsystems Corp ... 14-15
Arium Corp ... 273
ASIC** ... 211
AT&T Technologies ... 26-27
Autodesk ... 133
AVX Corp ... 39
B&C Microsystems ... 266
Beckman Industrial Corp ... 44
BICC-Vero Electronics Ltd ... 132
BP Microsystems ... 268
Bud Industries Inc* ... 219
B V Engineering ... 267
Cahners Exposition Group ... 101
Capital Equipment Corp ... 266
Case Technology ... 134-135
Commerce Tours International ... 100
Cybernetic Micro Systems ... 268
Cypress Semiconductor ... 56
Daisy Systems Corp ... 184
Dallas Semiconductor ... 110
Dasoft Design Systems Inc ... 151
Data I/O Corp ... C4
Deltrol Controls ... 266
Design Computation Inc ... 147
Dialight Corp ... 246
Dixy Corp ... 264
Douglas Electronics ... 156
Eagle Picher ... 112
EDN Caravan ... 182-183
Eldre Components Inc ... 266
Electrocube ... 96
Electronic Solutions ... 102
E-T-A Circuit Breakers ... 242
Ferranti Integrated Circuits** ... 207
Ferranti Interdesign Inc ... 89, 90-91
Fujitsu Microelectronics Inc* ... 54-55, 217
Futaba Corp of America ... 275
FutureNet/Div of Data I/O ... 149
Genstar REI Sales Co ... 267
GE/RCA Solid State ... 46-47, 122-123
Gespac Inc ... 71
Gould Inc, Design & Test Systems Div ... 50-53
Grayhill Inc ... 213
GTEK Inc ... 150
Hardigg Industries Inc ... 60-61
Heurikon Corp ... 223
Hewlett-Packard Co ... 28-29, 48-49, 94
Hitachi America Ltd/ Electron Tube Sales & Service Div* ... 157
Holmberg Electronics ... 236
Honeywell Test Instrument Div ... 226-227
Hughes Connecting Devices ... 279
Hunting Hivolt Ltd ... 219
Hybricon Inc ... 64
Hydelco ... 267
Hyundai Semiconductor ... 241
Inland Motors ... 261
Innovative Software Systems ... 266
In Power** ... 79
Insight Technology ... 267
Intel Corp ... 200-201
Interactive CAD Systems ... 265
International Recitifer ... C3
IRC Inc ... 222
John Fluke Manufacturing Co Inc ... 6, 73
Keithley Instruments Industrial Products ... 8
Kepco Inc ... 234
Laserpath ... 232-233
Leader Instruments Corp ... 113
Littlefuse Inc ... 271
Live Wire Software ... 266
Lockheed Electronics/ Environmental Test Labs ... 38
Logical Systems Corp ... 267
Lorain Products** ... 224
LSI Logic Corp ... C2
Luminescent Systems Inc ... 235, 237, 239
Mark Eyelet ... 259
Maxim Integrated Products ... 80
Medinova Corp ... 268
Memory Protection Devices Inc ... 177
Mentor Graphics Corp ... 10-11
Mepco/Centralab ... 244
Micro-Rel ... 62-63
MicroWay ... 245, 247, 249
Midwest Components ... 202
Miller-Stephenson Chemical Co Inc ... 126-127
Mini-Circuits Laboratories ... 24-25, 205, 292
Monolithic Memories Inc ... 16-17
National Semiconductor Corp ... 170-171, 174-175, 178-179, 180-181
NCR Corp ... 263
NCR Power Systems* ... 117
NEC Electronics Europe** ... 209
NEC Electronics Inc ... 59
New Micro ... 107
Nicolet Test Instruments Div ... 23
Nidec Tocin Corp ... 230
Nihon Kaiheiki Ind Co Ltd** ... 78
North America Mica Inc ... 265
Northwest Instrument Systems ... 199
Octagon Systems ... 267
Oliver Advanced Engineering Inc ... 85
Omation Inc ... 268
Optical Society of America ... 116
Optima Enclosures ... 254-255
OrCAD Systems Corp ... 154
Orion Instruments ... 45
PC Labs ... 265
Personal CAD Systems Inc ... 191
Philips Elcoma Div** ... 228A-D
Philips Test & Measuring Instruments Inc** ... 117, 157
Pico Electronics Inc ... 118
Pioneer International Inc ... 272
Pittman ... 44
Plessey Semiconductor ... 229
Polaroid Corp ... 231
Power-One Inc ... 43
Power Systems ... 250
Powertec Inc* ... 132A-D
Precision Monolithics Inc ... 215
Pro-Lib Inc ... 268
Pro-Log Corp ... 4
PTS Communications ... 268
QTech Inc ... 30
Qua Tech Inc ... 266
Qualidyne Systems Inc ... 96
Quelo Inc ... 268
Rhombus Industries ... 177
Rifa Inc/Power Products ... 193
Robinson-Halpern ... 265
Rogers Corp ... 268
Saft America Inc* ... 209
Scientific Calculations ... 243
Siemens AG** ... 54-55
Sierra Power Systems ... 125
Sierra Semiconductor ... 76-77
Signetics Corp ... 128-129
Silicon Systems Inc ... 74-75
Soltec Corp ... 99
Sonnenschein Batteries Inc ... 238
Sony Corp of America ... 192
Sophia Computer Systems Inc ... 194
Spectrum Software ... 248
Sprague Electric Co ... 31, 86-87, 267
Stag Microsystems Inc ... 18
STC Stantel ... 119
Summit Electronics ... 34
Sunrise Electronics Inc ... 88
Tatum Labs ... 267
TDK Corp ... 281
Tektronix Inc ... 32-33, 120-121, 145
Teledyne Relays ... 257
Teradyne Inc ... 136-137
Thomson Components-Mostek* ... 78-79
Tokin Corp ... 58
Toko America Inc ... 262
Triangle Digital Equipment ... 266
TRW/LSI Products Div ... 21
Tusonix Inc ... 225
Universal Data Systems ... 114
Versatec, A Xerox Co ... 155
Vicor Corp* ... 211
VideoLog Communications ... 253
Visionics Corp ... 1
Waferscale ... 251
Wavetek San Diego Inc ... 3
Westcor ... 2
WinSystems Inc ... 266
Wintek Corp ... 160, 267, 268
Xilinx ... 152-153
Zax Corp ... 66
Ziatech Corp ... 100A-F
Zilog Inc ... 105
Zoran ... 35-37
Zycad ... 82
Zymos Corp ... 92-93

Recruitment Advertising

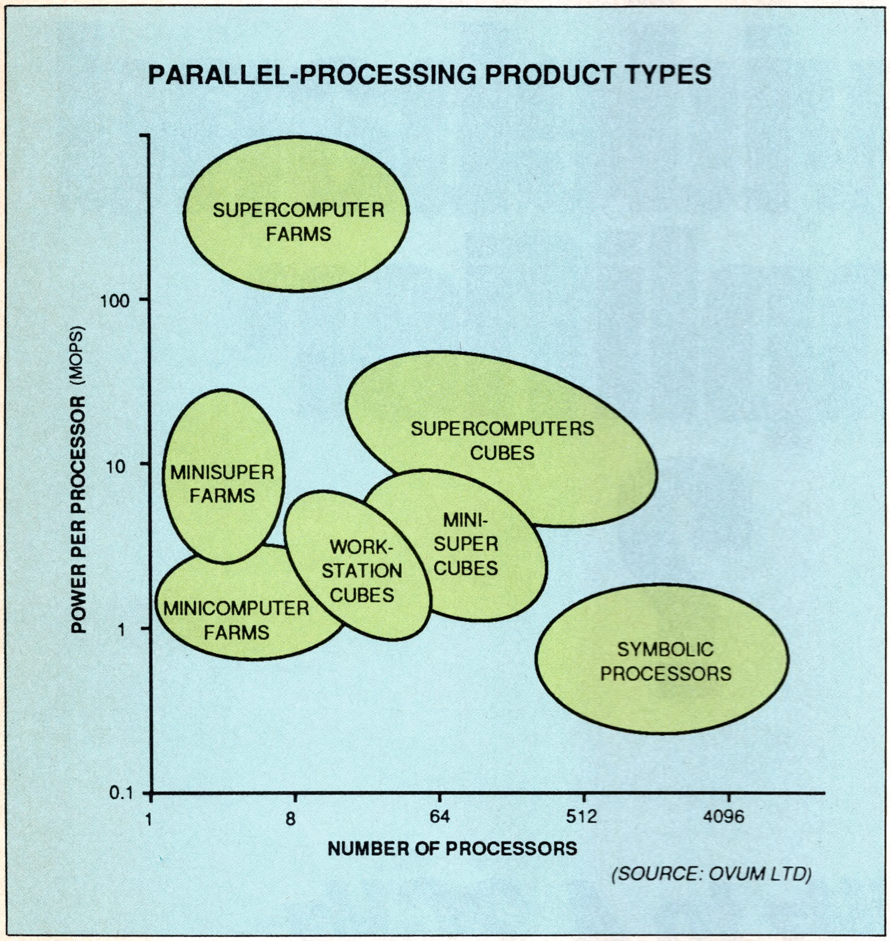
EG & G ... 83
Emerson Electric ... 89
Erim ... 85
Honeywell-Sperry Defense ... 84
ISC Aerospace ... 82
James E Iannoni & Assoc ... 82
Raytheon MSD ... 87

*Advertiser in US edition
**Advertiser in International edition

This index is provided as an additional service. The publisher does not assume any liability for errors or omissions.

LOOKING AHEAD

EDITED BY GEORGE STUBBS



(SOURCE: OVUM LTD)

Future of supercomputers lies in parallel processing

The total market for supercomputers employing parallel-processing architectures will increase from $600 million in 1986 to $8.6 billion in 1992, reports the market-research company Ovum Ltd of London, UK. One development having a significant impact on the overall supercomputer market, says Ovum, will be the use of industry-standard microprocessors or semicustom components in parallel architectures that will improve price/performance ratios.

The comparative costs per one million operations per second (mops) speak highly for parallel processing, says Ovum. The cost per mops on a minicomputer ranges from $30,000 to $60,000; the cost per mops for a parallel-processing machine can range from $400 to $12,000, with many machines falling in the $3000 to $6000 range. Parallel computers built from large numbers of low-cost μPs have some drawbacks, however. They do not generally have, as yet, the I/O channels, the different levels of memory, the language compilers, the programming environments, and other facilities that users require to achieve large throughputs.

Indeed, parallel processors will not be an entirely transparent innovation as far as the user is concerned, reports the market-research company. At a minimum, there will be changes in software and operating methods, and the opportunities offered by parallel processing may be so great that some users will want to change the working methods at fundamental levels. (See "Industry needs design-automation experts to unleash the power of supercomputers," EDN, August 7, 1986, pg 259.)

For the purposes of analysis, Ovum distinguishes between two different types of parallel-processing products. A typical "farm" comprises a small number of processors—usually no more than eight. These processors communicate through some form of shared memory, which they access over a bus or network of direct processor-to-processor connections. A "cube" incorporates large numbers of processors—128, 1024, or even 65,536, in the case of the Connection Machine built by Thinking Machines Corp (Waltham, MA).

Power ICs: one hot hitter in US semiconductor slump

In the still depressed US semiconductor market, one segment remains profitable and will continue to show strong sales figures for the foreseeable future. According to the market-research concern Frost & Sullivan Inc (New York, NY), power semiconductors currently constitute a $1 billion market and will form a $2.25 billion market in 1991.

The relatively new power ICs known as "smart power" devices are already in high demand, and growth in their sales will be the fastest of all power semiconductor types. The average annual growth rate over the period 1985 to 1991 will be 100%, from $10 million to $600 million.

F&S reports that FET-type power semiconductors—and particularly those of the MOSFET variety—are also quickly gaining in popularity. F&S estimates US MOSFET sales at $140 million for 1985, and it expects sales of these devices to total $580 million in 1991. Meanwhile, the standard "workhorse" devices—zener diodes and rectifiers, bipolar transistors, and thyristors—will continue to show steady market growth.

how wide is a wideband amplifier ?

10 MHz to 4.2 GHz

With its ultra-wide 10 to 4200MHz bandwidth, Mini-Circuits' ZHL-1042J 100mW amplifier is ideally suited for EW, TACAN, mobile radio, and satellite communications. A single ZHL-1042J can replace several "wideband" amplifiers in lab and production test setups.

The three-stage, 27dB gain 50-ohm class A design provides unconditional stability; any load impedance can be connected without concern for damage or oscillation. With 50dB reverse gain, excellent isolation is offered over the entire band, critical for closely-spaced frequency tests.

The noise figure of 18dB at 10MHz rapidly drops to 4.5dB at 100MHz and above; input SWR is 2.5. Output at the +1dB compression point is +20dBm and the intercept point is +30dBm.

The rugged heat-sinked 1.25 by 2.18 by 1.5 in. unit requires 15V, 0.3A.

Price is $495 (1-9 qty).

Immediate delivery, 1-year guarantee.

finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

CIRCLE NO 167

C106 REV. ORIG

NOW

The perfect low-cost answer to off-line switching

250V HEXFETs®

In the past, designing power FET switching for 117V line operation meant paying for more power handling capability than you really needed. But not any more.

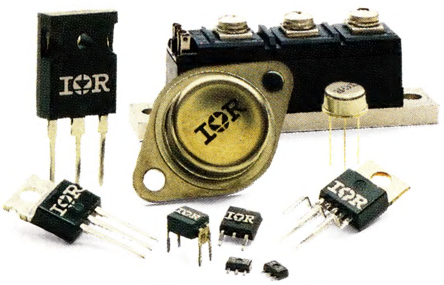
Our 250V HEXFET power MOSFETs offer a new family of *optimized* devices tailor-made to operate off-line – and all at prices of up to 50% less than conventional power FETs.

These cost-effective HEXFETs also guarantee you an extremely rugged device that handles full rated current/voltage without second breakdown, fast switching, and reliability second to none.

Five HEXFET 250V Series combine a wide variety of die sizes and package styles for off-line applications like battery chargers, hand drills, lighting ballasts, washing machines, dryers, and many others.

Rds (on) ranges as low as 0.13 Ohms, with current ratings as high as 28 amps depending on die size. For complete technical data, call (213) 607-8842. Today.

HEXFET Technology...
All 250V devices contain chips produced with our exclusive HEXFET process, resulting in unsurpassed quality and reliability.



Most HEXFETs now in stock for immediate delivery!

Number 1 in power MOSFETs

International IOR Rectifier

WORLD HEADQUARTERS: 233 KANSAS ST., EL SEGUNDO, CA 90245. U.S.A. (213) 772-2000. TWX 910-348-6291, TELEX 472-0403
EUROPEAN HEADQUARTERS: HURST GREEN, OXTED, SURREY RH8 9BB. ENGLAND TELEPHONE (088 33) 3215/4231. TELEX 95219

Power MOSFETs • CMOS Power ICs • Commercial/Custom Power Packages • Schottkys
Rectifiers • Thyristors (SCRs) • Diode Bridges • Molded Circuits • Assemblies

CIRCLE NO 61

1400 REASONS TO BUILD YOUR PROGRAMMING FUTURE ON THE 29B.

START WITH THE SUPPORT YOU NEED TODAY, AND BUILD YOUR WAY TO UNIVERSAL PROGRAMMING. With algorithms for more than 1400 programmable devices, the 29B Universal Programming System gives you the freedom to choose the right device for your design. And even though we support virtually every device on the market today, you don't have to buy all that support at once. For example, you can start with gang and set programming for EPROMs and EEPROMs. Later expand your system by adding logic or bipolar PROM programming.

Gradually, or all at once, you can build a full universal programming system. Our modular system of paks gives you complete programmable device support and is one of the major reasons the 29B has become the industry standard. You can buy for today's needs, while keeping your options open for future expansion.

MANUFACTURER-APPROVED ALGORITHMS FOR RELIABILITY. Our modular approach to device support is just part of the 29B story. With its manufacturer-approved algorithms, the 29B excels at programming each device accurately. So whether you operate the 29B as a stand-alone, from a personal computer, or a terminal on your company's mainframe, you're guaranteed reliable trouble-free programming, year-after-year.

PROGRAMMING PERFORMANCE FOR TODAY. When successful companies want universal programming support, they turn to Data I/O. For more than 14 years we've maintained a steady commitment to support every device, so that you have the programming performance you need today.

SEND FOR A DATA I/O WALL CHART OR DISKETTE. Start building your future today with the 29B Universal Programming System. Today the 29B supports 1400 devices. Tomorrow it will support even more. To make sure you have the latest listing of device support, complete this coupon and indicate whether you prefer a wall chart or diskette. (Enclose $2.00 for postage and handling.)

SEND $2.00 TO:
Data I/O Corporation
Attn: Marketing
Communications
10525 Willows Rd. N.E.
P.O. Box 97046
Redmond, WA 98073-9746

EDN031887

Name ________________

Title ________________

Company ________________

Address ________________

____

☐ Wall Chart ☐ Diskette
(MS-DOS compatible)

Distributed by Hamilton/Avnet.

Data I/O Corporation 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. (206) 881-6444/Telex 15-2167
FutureNet 9310 Topanga Canyon Boulevard, Chatsworth, CA 91311-7528 (818) 700-0691/Telex 910-494-2681
Data I/O Canada 6725 Airport Road, Suite 302, Mississauga, Ontario L4V 1E5 (416) 678-0761
Data I/O Europe World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands (20) 622866/Telex 16616 DATIO NL
Data I/O Germany Bahnhofstrasse 3, D-6453 Seligenstadt, Federal Republic of Germany (6182) 3088/Telex 4184962 DATA D
Data I/O Japan Sumitomoseimei Highashishinbashi Bldg., 8F, 2-1-7, Highashi-Shinbashi, Minato-ku, Tokyo 105, Japan (03) 432-6991/Telex 2522685 DATAIO J

DATA I/O

CIRCLE NO 58